Ch. 1 Assessment

Due: 8:30am on Monday, September 9, 2024

To understand how points are awarded, read the Grading Policy for this assignment.

Get Ready for This Chapter: Chapter 1 Question 1

In this chapter, you will learn about some unifying themes in the study of life, how evolution accounts for the unity and diversity of life, and characteristics of successful scientific inquiry. After reading the chapter overview, you should be able to describe the basic concept of evolution. The following question provides a quick check of your basic knowledge in this area.

Part A

Which of the following statements is true regarding evolution?

ANSWER:

- Evolution is the process that always results in the extinction of species.
- Evolution is a process of biological change in which species accumulate differences from their ancestors as they adapt to different environments over time.
- Evolution is the process of change over an organism's lifetime.
- Individual organisms adapt to their surroundings, and this is called evolution.

Get Ready for This Chapter: Chapter 1 Question 2

In this chapter, you will learn about some unifying themes in the study of life, how evolution accounts for the unity and diversity of life, and characteristics of successful scientific inquiry. After reading the chapter overview, you should be able to list the five unifying themes of biology and apply them to new examples. The following question provides a quick check of your basic knowledge in this area.

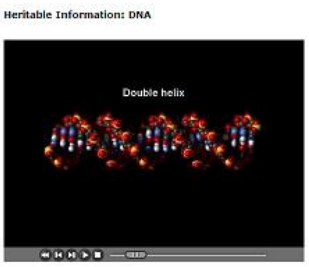
Part A

When you eat pizza, the molecules in the pizza are broken down in your cells and carbon is released to the air in the form of carbon dioxide. This is an example of which theme?

ANSWER:

- Genetic information encoded in DNA determines the structure of proteins.
- Organisms interact.
- Structure fits function at all levels of organization.
- Matter cycles between an organism and its environment.

Activity: Heritable Information: DNA



Watch the animation.

Then answer the questions.

Part A

DNA is composed of building blocks called _____.

ANSWER:

- nucleic acids
- Gs
- nucleotides
- adenines
- amino acids

Part B

In eukaryotic cells DNA has the appearance of a _____.

ANSWER:

- single strand
- letter U
- double helix
- triple helix
- circle

Misconception Question 3

Part A

The universal genetic language of DNA is common to virtually all organisms on Earth, however diverse. What is the best explanation for this fact?

ANSWER:

- All living things share a common genetic language of DNA because they share a common ancestry.
- The universal nature of the genetic language of DNA is due to coincidence.
- The universal genetic language is explained by the chemistry of DNA and proteins.

Misconception Question 1

Part A

Which example illustrates a property that emerges at the community level?

ANSWER:

- Nitrogen cycling is the process by which nitrogen from the atmosphere and decomposed organic material are converted by soil bacteria to compounds that can be assimilated by plants.
- Metabolic cooperation among many species of prokaryotic cells forms a biofilm that allows bacterial colonies to transport nutrients and wastes. Biofilms may damage industrial equipment or cause tooth decay.
- Photosynthesis takes place only when pigment molecules are arranged in a specific way in an intact chloroplast.

Misconception Question 2

Part A

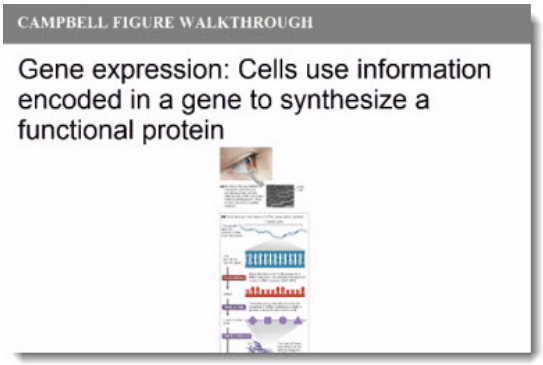
Select the most accurate statement about the interaction between a tree and its physical environment.

ANSWER:

- A tree is affected by its physical environment.
- A tree alters its physical environment.
- A tree and its physical environment alter each other.

Campbell Figure Walkthrough: Gene Expression: Cells Use Information Encoded in a Gene to Synthesize a Functional Protein

Watch this video and then answer the questions.



Part A

What does it mean to say that a gene is expressed?

ANSWER:

- Lens cells make crystallin protein.
- DNA contains the information needed to make a protein.
- A protein is used to make DNA.
- Information in DNA is used to make a protein.

Part B

How many different kinds of nucleotides does DNA contain?

ANSWER:

- 2: wound in a double helix
- 4: A, C, T, G
- 5: A, C, T, G, U
- Thousands: Each contains information for how to make a different protein.

Part C

Why doesn't a skin cell make crystallin protein?

Select all that apply.

ANSWER:

- [ ] Skin cells have the crystallin gene but do not express it.
- [ ] The crystallin gene is not present in skin cells.
- [ ] Skin cells use different DNA for their genes.
- [ ] Skin cells do not need crystallin for their function.

Chapter 1 Question 1

Part A

All the organisms on your campus make up

ANSWER:

- ○ a community.
- ○ a population.
- ○ a taxonomic domain.
- ○ an ecosystem.

Chapter 1 Question 2

Part A

Systems biology is mainly an attempt to

ANSWER:

- ○ analyze genomes from different species.
- ○ understand the behavior of entire biological systems by studying interactions among its component parts.
- ○ simplify complex problems by reducing the system into smaller, less complex units.
- ○ build high-throughput machines to rapidly acquire data.

Chapter 1 Question 3

Part A

Which of these best demonstrates unity among organisms?

ANSWER:

- ○ natural selection
- ○ descent with modification
- ○ emergent properties
- ○ the structure and function of DNA

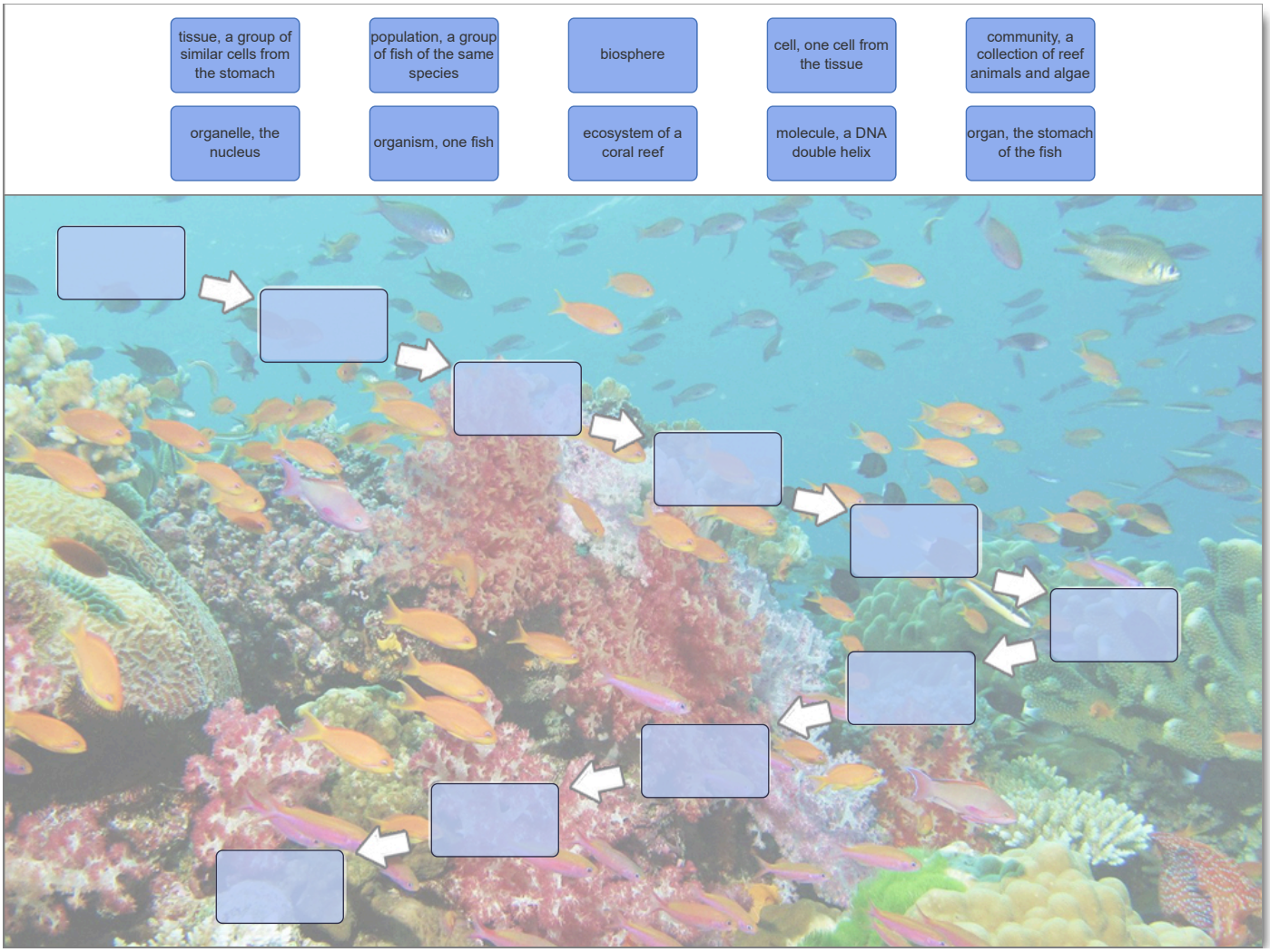
Chapter 1 Question 8

Part A

Compose a biological hierarchy for a coral reef as the ecosystem, a fish as the organism, its stomach as the organ, and DNA as the molecule. Include all levels in the hierarchy and start from the higher level of biological organization.

Drag the appropriate labels to their respective targets.

ANSWER:



Chapter 1 Pre-Test Question 1

Part A

What is the correct order for the hierarchy of biological organization from the least to the most complex?

You did not open hints for this part.

ANSWER:

- molecule, organelle, cell, tissue, organ, organism, population, ecosystem, community, biosphere
- molecule, organelle, cell, tissue, organ, organism, population, community, ecosystem, biosphere
- molecule, organelle, cell, tissue, organ, organism, ecosystem, community, population, biosphere
- molecule, cell, tissue, organelle, organ, organism, population, community, ecosystem, biosphere
- molecule, organelle, tissue, cell, organ, organism, population, community, ecosystem, biosphere

Chapter 1 Pre-Test Question 2

Part A

No amino acid molecule by itself can speed up or catalyze reactions between other molecules. However, when amino acids are joined together to make a protein with catalytic properties, the new structure (enzymatic protein) can speed up the rate of a specific chemical reaction. What does this illustrate?

You did not open hints for this part.

ANSWER:

- polymer duality
- the summation theory
- energy flow, processing, and utilization
- the complexity/simplicity paradox
- emergent properties

Chapter 1 Pre-Test Question 3

Part A

Which of the following statements about chemical nutrients in an ecosystem is correct?

You did not open hints for this part.

ANSWER:

- They depend on sunlight as their source.
- They exit the ecosystem in the form of heat.
- They cannot be obtained from decomposition.
- They flow through the ecosystem, losing some nutrients in the process.
- They recycle within the ecosystem, being constantly reused.

Chapter 1 Pre-Test Question 4

Part A

Which of the following attributes is common to both prokaryotic cells and eukaryotic cells?

You did not open hints for this part.

ANSWER:

- the use of proteins as information storage molecules
- membrane-enclosed organelles
- similarity in size
- the use of DNA as the information-storage molecule
- a membrane-enclosed nucleus

Chapter 1 Pre-Test Question 5

Part A

How does DNA (deoxyribonucleic acid) encode information?

You did not open hints for this part.

ANSWER:

- information is encoded in the different shapes of the DNA molecules
- the DNA molecule is composed of many amino acids joined together to form a functional protein
- information is encoded in the sequence of nucleotides
- information is encoded in the number of each different nucleotide
- the genes along the length of DNA molecules encode the information for building all the cell's other molecules

Chapter 1 Question 9

Part A

EVOLUTION CONNECTION

A typical prokaryotic cell has about 3,000 genes in its DNA, while a human cell has about 21,300 genes. About 1,000 of these genes are present in both types of cells. How do you explain how such different organisms could have this same subset of 1,000 genes?

ANSWER:

- The subset of genes shared by humans and prokaryotes is the same due to the universality of the genetic code.
- The subset of genes shared by humans and prokaryotes have originated separately and is the same due to a similar environment.
- The subset of genes shared by humans and prokaryotes originates from a common ancestor and has been retained over billions of years of evolution.
- The subset of genes shared by humans and prokaryotes originates from random mutations that occurred and accumulated during billions of years of evolution.

Part B

What sorts of functions might these shared genes have?

ANSWER:

- coding for ribosomal RNA
- regulation of DNA replication
- coding for crystallin proteins
- coding for nuclear proteins

Chapter 1 Question 1

Part A

Which of the following statements about cells is correct?

ANSWER:

- Cells are limited in size, which is between 200 to 500 micrometers in diameter.
- Single cells cannot exist independently.
- Both prokaryotic and eukaryotic organisms are made up of cells.
- Some cells are non-living in nature.

Chapter 1 Question 4

Part A

To understand the chemical basis of inheritance, we must understand the molecular structure of DNA. This is an example of the application of which concept to the study of biology?

ANSWER:

- emergent properties
- feedback regulation
- reductionism
- evolution

Chapter 1 Question 5

Part A

A double-stranded DNA molecule with three guanine and five thiamine nucleotides (in 5 3 strand) has how many nucleotides in total?

ANSWER:

- 16
- 8
- 5
- 3

Chapter 1 Question 6

Part A

Which of the following statements is true regarding the complexity of biological systems?

ANSWER:

- Knowing the function of a component of a living system can provide insights into the structure and organization of the living system.
- An ecosystem displays complex properties of the biotic component only.
- An understanding of the interactions between different components within a living system is an approach towards understanding reductionism.
- Understanding the chemical structure of DNA reveals how it directs the functioning of a living cell.

Chapter 1 Question 2

Part A

A cell lacking which of the following structures is most likely to be a prokaryote?

ANSWER:

- Nuclear membrane
- Cell membrane
- Nucleic acid
- Cytoplasm

Chapter 1 Question 8

Part A

Apple on tree ripens. A ripe apple produces ethylene that signals neighboring apples to ripen. Neighbor apples produce more ethylene and more apples ripen.

The above process is an example of which of the following?

ANSWER:

- emergent properties
- positive feedback regulation
- chemical cycling
- negative feedback regulation

Chapter 1 Question 9

Part A

Which of the following is the correct order of organization of genetic material from smallest to largest?

ANSWER:

- gene, nucleotide, chromosome, genome
- chromosome, genome, nucleotide, gene
- genome, chromosome, gene, nucleotide
- nucleotide, gene, chromosome, genome

Chapter 1 Question 7

Part A

Which statement about ecological organization is correct?

ANSWER:

- A community is part of a population.
- An ecosystem is made up of organisms only
- Biosphere is a part of the ecosystem
- An organism is part of a community.

Chapter 1 Question 3

Part A

Which of the following types of cells use deoxyribonucleic acid (DNA) as their genetic material but do not have their DNA encased within a nuclear envelope?

ANSWER:

- archaean
- plant
- animal
- fungi

Chapter 1 Question 11

Part A

Three important research developments that have made the genomic and proteomic approaches possible are _____.

ANSWER:

- high throughput technology, bioinformatics, and interdisciplinary research teams
- computers, nanotechnology, and bioinformatics
- bioinformatics, gene therapy, and genetically modified organisms
- cloning, computers, and gene therapy

Chapter 1 Question 10

Part A

As letters are to English language, _____ is/are to genetic information.

ANSWER:

- proteins
- carbohydrates
- DNA double helix
- nucleotides

Chapter 1 Pre-Test Question 6

Part A

Which taxonomic domain includes multicellular photosynthetic organisms? See Concept 1.2 (Page)

You did not open hints for this part.

ANSWER:

- Fungi
- Archaea
- Plantae
- Bacteria
- Eukarya

Chapter 1 Pre-Test Question 7

Part A

Competition is central to the theory of natural selection. Why does competition occur?

You did not open hints for this part.

ANSWER:

- organisms are naturally antagonistic
- males must defend their territories
- females must choose among possible mates
- organisms typically produce too many offspring and resources are limited
- all of the listed responses are correct

Chapter 1 Pre-Test Question 8

Part A

Which of the following statements demonstrates unity in the diversity of life?

You did not open hints for this part.

ANSWER:

- All organisms, including prokaryotes and eukaryotes, use essentially the same genetic code.
- The forelimbs of all mammals have the same basic structure, modified for different environments.
- The structure of DNA is the same in all organisms.
- Cilia and flagella in all eukaryotes have the same basic structure.
- All of the listed statements are correct.

Chapter 1 Question 10

Part A

SCIENTIFIC INQUIRY

Based on the results of the mouse coloration case study, suggest another hypothesis researchers might use to study the role of predators in natural selection.

ANSWER:

- You might wonder what would happen if a population of beach mice was mixed with a population of dark inland mice.
- You might wonder what would happen if a population of beach mice lived in an area where predators were replaced with other predators.
- You might wonder what would happen if the owl was allowed to hunt during daytime.
- You might wonder what would happen if a population of beach mice lived in an area where predators were absent.

Part B

Complete the description of how to test the hypothesis.

Match the terms in the left column to the appropriate blanks in the sentences on the right. Not all terms will be used.

ANSWER:

Reset Help

would not
long
light
would
short
dark

It might be possible to do a [ ] -term study in an area where you excluded predators. Mice have [ ] generation times, so if predation is "naturally selecting" lighter colored mice, then in the absence of predation you might predict the fur color [ ] remain predominantly [ ] in such an experimental population.

Chapter 1 Question 12

Part A

Which observations did Darwin make?

Select the *three* correct statements.

ANSWER:

- A population has more individuals than can be supported by the environment.
- All organisms share similar features.
- The population size suits the resources of the environment.
- Heritable variations exist in each population.
- Each individual frequently and continuously uses the necessary organs.
- Each species seems suited for its particular environment.

Part B

Complete Darwin's view of how natural selection resulted in both unity and diversity of life.

Match the terms in the left column to the appropriate blanks in the sentences on the right. Not all terms will be used.

ANSWER:

Reset Help

more
natural selection
diversity
less
evolutionary adaptation
individuals in a population
populations
unity

According to his observations, Darwin proposed that the best-suited [ ] would survive and reproduce [ ] successfully than those [ ] adapted to their environment, and he called this "[ ]."

This mechanism could account for both the unity and diversity of features among species. The similarities between the descent organisms and their common ancestor explain the [ ] of life, while the force of natural selection in different environments accounts for the [ ] of life.

Chapter 1 Question 13

Part A

Can you pick out the mossy leaf-tailed gecko lying against the tree trunk in this photo? How is the appearance of the gecko a benefit in terms of survival?

Select the *two* correct statements.

ANSWER:

- [ ] This coloration likely makes it harder for the gecko to find a breeding partner.
- [ ] This coloration likely makes it harder for the gecko to be seen by predators.
- [ ] This coloration likely makes it easier for the gecko to find a breeding partner.
- [ ] This coloration likely makes it harder for the gecko to hunt insects.
- [ ] This coloration likely makes it easier for the gecko to hunt insects.
- [ ] This coloration likely makes it easier for the gecko to be seen by predators.

Part B

Given what you learned about evolution, natural selection, and genetic information, describe how the gecko's coloration might have evolved.

Rank the stages from earliest to oldest.

ANSWER:

Reset Help

Over the generations, the coloration would become a closer and closer match to the tree bark.

Geckos that more closely resembled their background are less visible to predators and are more likely to survive, reproduce, and leave offspring.

There are geckos of different coloration in a population.

The offspring would inherit the genes that generated the mossy bark coloration.

Chapter 1 Question 18

Part A

An individual is suffering from a streptococcus infection in their throat. Which of the following do the individual and the streptococcus bacteria have in common?

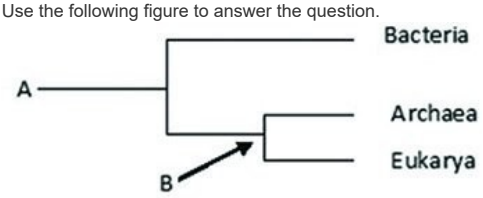
ANSWER:

- They both are made up of cells.
- They both belong to the same domain.
- They both have genetic material in their nucleus.
- The individual and *Streptococcus* have nothing in common.

Chapter 1 Question 17

Part A

Use the following figure to answer the question.



Describe groups labeled A and B.

ANSWER:

- A is the common ancestor of all life whereas B is the common ancestor of Bacteria and Archaea
- A is the most recent species to evolve on Earth whereas B is an ancestor of group "A"
- A is the most recent species to evolve on Earth whereas B is the last common ancestor of Archaea and Eukarya
- A is the common ancestor of all life whereas B is the last common ancestor of Archaea and Eukarya

Chapter 1 Question 19

Part A

Which of the following is an example of genetic variation?

ANSWER:

- One of the twins has a scar the other does not
- One sibling has brown eyes, the other has green
- One sibling is vegan, the other eats meat
- Two brothers who are twins

Chapter 1 Question 13

Part A

Which of the following statements about genetic information is correct?

ANSWER:

- A typical human liver cell has one set of chromosomes
- mRNA is the only type of RNA found in a eukaryotic cell
- DNA is not found in prokaryotic cells
- All forms of life employ the same genetic code

Chapter 1 Question 16

Part A

Which branch of biology is concerned with the naming and classifying of organisms?

ANSWER:

- taxonomy
- evolution
- informatics
- genomics

Chapter 1 Question 15

Part A

Two organisms are _____ if they share more classification levels.

ANSWER:

- easier to tell apart
- further apart in the food chain
- more similar in characteristics
- closer together in the biosphere they live

Chapter 1 Question 20

Part A

Which of the following is one of Charles Darwin's observations?

ANSWER:

- Individuals in a population are similar in their traits.
- Many of the traits in an individual are heritable.
- Species generally are not adapted to their environments.
- A population avoids competition by producing only as many offspring as can successfully reproduce on their own.

Chapter 1 Question 14

Part A

Which of these provides evidence of the common ancestry of all life?

ANSWER:

- structure of the nucleus
- near universality of the genetic code
- structure of cilia
- structure of chloroplasts

Chapter 1 Question 21

Part A

The evolution two or more species from one species as a result of different populations becoming reproductively isolated from each other is best described as _____.

ANSWER:

- creationism
- prototype
- adaptive radiation
- natural selection

The Scientific Method

Learning Goal:
To understand how the scientific method can be used to search for explanations of nature.

The *scientific method* is a procedure used to search for explanations of nature. The scientific method consists of making observations, formulating hypotheses, designing and carrying out experiments, and repeating this cycle.

Observations can be either quantitative or qualitative. *Quantitative observations* are measurements consisting of both numbers and units, such as the observation that ice melts at $0^{\circ}\mathrm{C}$. In contrast, *qualitative observations* are observations that do not rely on numbers or units, such as the observation that water is clear.

A *hypothesis* is a tentative explanation of the observations. The hypothesis is not necessarily correct, but it puts the scientist's understanding of the observations into a form that can be tested through experimentation.

Experiments are then performed to test the validity of the hypothesis. *Experiments* are observations preferably made under conditions in which the variable of interest is clearly distinguishable from any others.

If the experiment shows that the hypothesis is incorrect, the hypothesis can be modified, and further experiments can be carried out to test the modified hypothesis. This cycle is repeated, continually refining the hypothesis.

If a large set of observations follow a reproducible pattern, this pattern can be summarized in a *law*—a verbal or mathematical generalization of a phenomenon. For example, over the years people observed that every morning the sun rises in the east, and every night the sun sets in the west. These observations can be described in a law stating, "The sun always rises in the east and sets in the west."

After a great deal of refinement, a hypothesis can lead to a theory. A *theory* is an explanation of why something happens. For example, Newton's theory of gravitation explains why objects tend to fall toward the Earth (as well as explaining the interactions between the Earth and the other planets, etc). However, theories can still be further refined or even replaced. Einstein's theory of general relativity was able to better explain certain astronomical observations related to gravity, and therefore it replaced Newton's theory of gravitation (although Newton's theory still holds true under most everyday conditions). Similarly, the geocentric theory (that the Earth is the center of the universe) was replaced by the heliocentric theory (that the Earth revolves around the sun) based on further observations and testing of predictions. Note that a scientific theory is not the same as the popular definition of a theory—namely, a "guess" or "speculation." Instead, a theory is an explanation that can hold up against repeated experimentation. It may not be perfect, but it is the best explanation possible based on available evidence.

In the course of a conversation, you observe that three of your friends like horror movies. Horror movies happen to be your favorite type of movie as well. You also know that all of these friends were born in the same week that you were, even in the same year.

An astrology-loving friend hypothesizes that people born in that week like horror movies more than other genres of movies. You decide to use the scientific method to test this hypothesis.

Part A

What should you do next?

ANSWER:

- Come up with a theory to explain why movie preference is related to birth week.
- Perform experiments to test your hypothesis.
- Propose several alternative hypotheses.
- Refine your hypothesis.

Part B

Which of the following experiments would best test your hypothesis?

ANSWER:

- Ask your friends if they also like the same type of music that you like.
- Interview all of your friends and find out if the ones born in other weeks also like the same types of movies that you like.
- Find other people born in the same week and ask them what their favorite type of movie is.
- Find other people born in the same week and tell them what your favorite movie is. Ask them if they also liked that movie.

You want to be as careful as possible that the variable of interest--namely, favorite movie genre--is clearly distinguishable from any other variables. To do so, first you must be careful to find a random sampling of people who share your birth week, avoiding simply talking to friends with whom you share common interests. Second, you need to provide your subjects with a questionnaire on which they are asked to circle their favorite genre from a list, so that you are not tempted to interpret their answers in your favor. You must be certain not to tell them what you are seeking to prove or disprove; that way their answers will not be influenced by your stated goal. You must also make the surveys anonymous to ensure that your subjects aren't simply giving you the answers they think you want them to give.

After finding a random sample of 10 people born in the same week as you and your friends, you obtain these results from their questionnaires:

- 4 of them prefer comedies,
- 3 of them prefer dramas,
- 2 of them prefer action movies, and
- 1 of them prefers westerns.

As a control, you also interview 14 random people with birthdays throughout the year. You obtain results similar to the results of your experimental group and your friends:

- 3 of them prefer comedies,
- 4 of them prefer dramas,
- 3 of them prefer action movies, and
- 1 of them prefers westerns

Part C

What should you do next?

ANSWER:

- Refine your hypothesis.
- Come up with a theory to explain why movie preference is only sometimes related to birth week.
- Perform further interviews until you find more people who prefer horror movies.
- Assume that the 10 people you interviewed were lying about their birth week. Conduct further interviews in which you ask movie preference first and only ask about birth week when people say they like horror movies.

The scientific method can be used to examine many ideas, not just those in biology, so long as the hypothesis can be tested through observable evidence.

Activity: Introduction to Experimental Design

Click here to view this animation.

Then answer the questions.

Part A

Which of the following statements is *not* true of scientific experiments?

ANSWER:

- They must occur under carefully controlled conditions found in a laboratory.
- They must be well documented.
- They yield useful results regardless of whether the hypothesis is supported or rejected.

Part B

In an experiment, investigators try to control all of the variables except one—the one that tests the hypothesis. Which of the following reasons is the primary rationale for controlling variables in an experiment?

You did not open hints for this part.

ANSWER:

- To enable investigators to repeat the test
- To create a control group
- To eliminate alternative explanations for the results of an experiment

Part C

Which of the following statements could *not* be supported or rejected by a scientific experiment?

You did not open hints for this part.

ANSWER:

- College students think football is more fun to watch than baseball.
- Grass is green because it contains chlorophyll.
- The first living cell on Earth came from outer space

Part D

Which of the following statements is true of a hypothesis?

You did not open hints for this part.

ANSWER:

- A hypothesis can be proved.
- A hypothesis can be supported or rejected through experimentation.

Part E

Which of the following variables did Pasteur change in his experiment to test the hypothesis of spontaneous generation?

You did not open hints for this part.

ANSWER:

- The broth used in each flask
- The shape of the flask
- The length of time that the flasks were allowed to sit before being sampled for organisms
- The length of time that the broth was boiled

Part F

In Pasteur's experiment to test the hypothesis of spontaneous generation, why did he boil the broth in both flasks?

You did not open hints for this part.

ANSWER:

- To attract dust particles to each flask
- To provide nutrients to stimulate the growth of microorganisms
- To expose the broth to a source of organisms
- To kill any existing organisms in the broth

Part G

Suppose the sub-hypothesis that wing waving alone reduces predation by jumping spiders was supported by the *Zonosemata* experiment. What results would have supported that sub-hypothesis?

ANSWER:

- *Zonosemata* flies with their own wings cut and reglued are attacked less frequently.
- Houseflies with *Zonosemata* wings are attacked less frequently.
- *Zonosemata* flies with housefly wings are attacked less frequently.
- Untreated *Zonosemata* flies are attacked less frequently.

Part H

Suppose that *Zonosemata* flies whose own wings had been clipped and reattached were attacked more frequently than untreated *Zonosemata* flies. How would this result have affected the reliability of the other experimental results?

ANSWER:

- The reliability of the experimental results would not change.
- All results for the experimental groups using *Zonosemata* flies would be invalid.
- All results for the experimental groups involving wing surgery would be invalid.
- All results for the experimental groups using houseflies would be invalid.

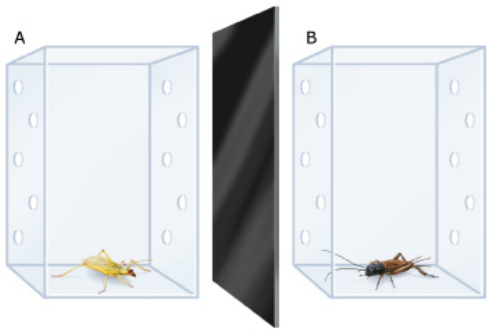
Experimental Inquiry: What Can You Learn About the Process of Science from Investigating a Cricket's Chirp?

Most species in the insect order Orthoptera (crickets, grasshoppers, locusts) produce a song by rubbing their wings or legs against each other. In most of the species that sing, only the male produces a song.

Crickets are a common example; their songs are a familiar night sound in most parts of the continental United States. Some crickets produce a song that is continuous for several seconds or more, while others break their song into a sequence of chirps, typically with 10-50 chirps per minute.

Part A - Experimental technique: Experimental and control groups

Based on the observation that only male crickets produce a song, you hypothesize that a male's song is a form of communication to potential mates.
You set up a simple experiment to test this hypothesis. In the laboratory, you place a male snowy tree cricket in enclosure A, which is adjacent to enclosure B. In enclosure B, you place other insects, one at a time, and observe their responses to the male's song.



The enclosures are designed so that the two insects being tested cannot see or smell each other, but sound is transmitted from enclosure A to enclosure B.

For each insect below, indicate whether it is part of an experimental group or a control group when placed in enclosure B. Labels may be used once, more than once, or not at all.

You did not open hints for this part.

ANSWER:

Reset Help

experimental group

control group

Cricket	Experimental or Control
 male snowy tree cricket	
 female snowy tree cricket	
 female field cricket	

Part B - Graphing experimental data

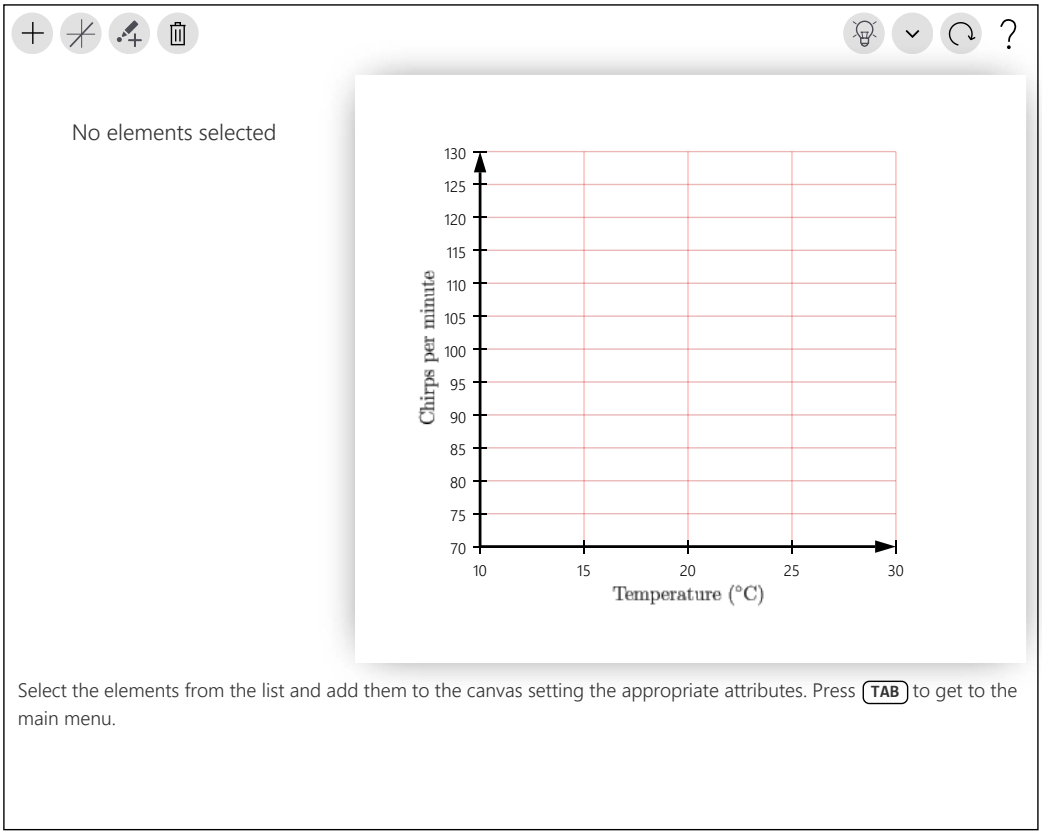
There are many reports that the number of chirps per minute that a cricket produces is correlated with the ambient temperature. Your class decides to test this hypothesis by collecting several males from two species of crickets: the snowy tree cricket (*Oecanthus fultoni*) and the common field cricket (*Gryllus pennsylvanicus*). In the laboratory, you measure the chirp rate of each cricket at four different temperatures. The data are shown in the table below.

Temperature (°C)	Average chirp rate (chirps per minute)	
	Snowy tree cricket	Common field cricket
15	99	73
20	108	82
25	117	90
30	128	100

Plot the data for the two species of crickets, one graph for the snowy tree cricket and a separate graph for the common field cricket. To plot the data for each species, click "Add Element" and then select the appropriate graph label.

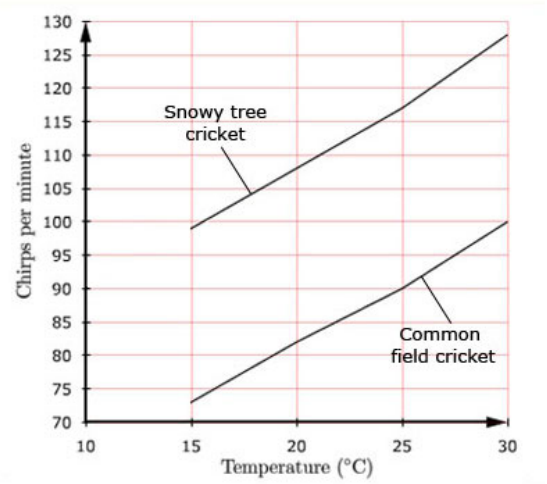
You did not open hints for this part.

ANSWER:



Part C - Interpreting experimental results

The process of science is not limited to acquiring and visualizing data (as you did in Part B). Analysis and interpretation of the data are also essential parts of scientific investigation.

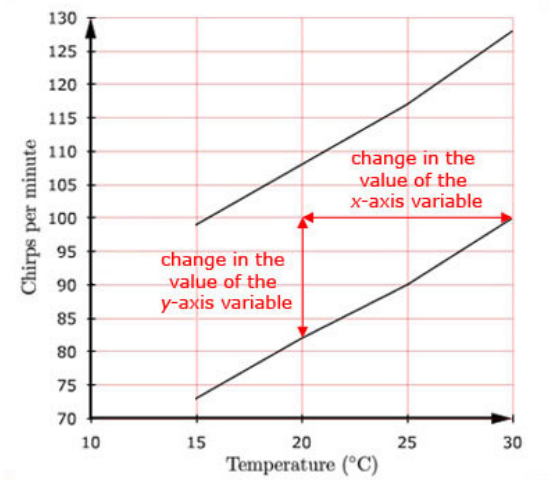


The graph that you produced in Part B is reproduced here.

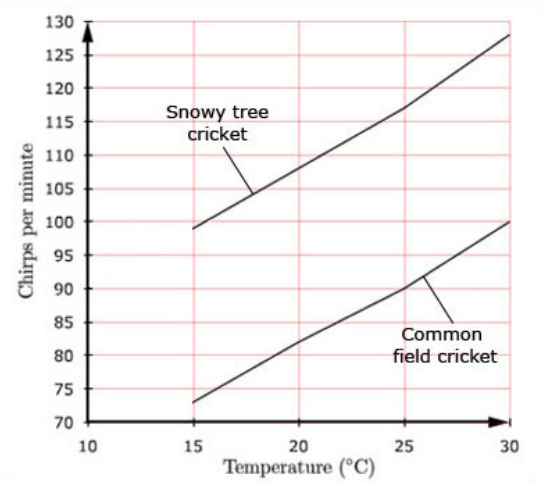
Which *three* of the following statements are valid conclusions that could be drawn from the graph above?

Hint 1. How to interpret the change in chirp rate with each change in temperature

The change in the number of chirps per minute (the chirp rate) with each change in temperature is just another way of describing the slope of the line. The slope is the change in the value of the *y*-axis variable per change in the *x*-axis variable.



Hint 2. Can you compare the difference in chirp rates across the range of temperatures tested?



Which of the following statements best describes the difference between the two species' chirp rates across the range of temperatures tested?

ANSWER:

- The two species' chirp rates are the same at each temperature.
- The difference between the two species' chirp rates is much larger at 30 °C than at 15 °C.
- The difference between the two species' chirp rates is about the same at each temperature.

Hint 3. The range of values shown on the *x*-axis

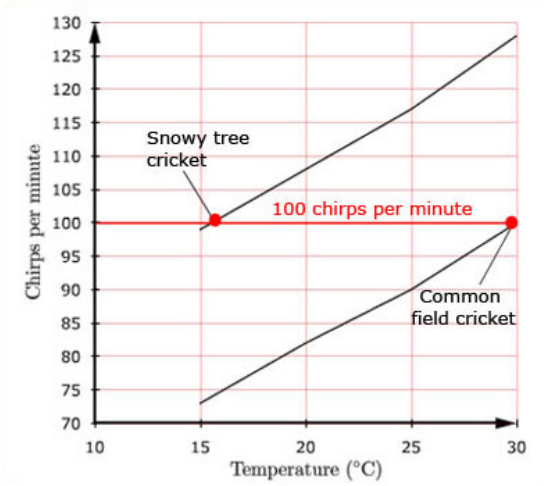
In this graph, the data you plotted fall between 15 °C and 30 °C, which reflect the range of temperatures that you tested. It does not mean that these crickets do *not* sing when the temperature is below 15 °C or above 30 °C, only that you did not test their songs at temperatures outside that range.

ANSWER:

- [ ] Crickets of these two species sing only at temperatures between 15 °C and 30 °C.
- [ ] The difference between the chirp rates of the two species remains fairly constant across the range of temperatures tested.
- [ ] It is possible for a male snowy tree cricket and a male field cricket to sing with the same chirp rate, but only at different temperatures.
- [ ] The change in chirp rate with each change in temperature is similar for the two species.

Part D - Experimental prediction: The effect of temperature on the female's response to the male's song

In Part C, you observed that different species of crickets could sing at the same chirp rate, but only at different temperatures. The figure below shows, for example, that the snowy tree cricket and the common field cricket can both produce songs with 100 chirps per minute, but the snowy tree cricket does so at about 16 °C while the common field cricket does so at about 30 °C.



Because you found these two species coexisting in the same region where you collected them, you form the following hypothesis and prediction:
Hypothesis: Female crickets respond to both the chirp rate of the male's song *and* the local temperature when identifying potential mates.
Prediction: If the female is at a different temperature from the male, she will not respond to the male's song even if it is a male of the same species.

To test your hypothesis, you use the same laboratory setup that you used in Part A. The only difference is that now the temperature of the two enclosures can be independently controlled. In your proposed experiment:

- A male snowy tree cricket will be placed in the first enclosure and kept at 25 °C.
- A sexually mature female snowy tree cricket will be placed in the second enclosure, and its response to the male's song will be determined at several different temperatures between 10 °C and 40 °C.

Based on your observations in Part A, you score the response of the female on a scale of 0 to 10, where 10 represents the female turning directly toward the singing male and 0 represents no motion or random turning.

Assuming your hypothesis is supported, which of the following graphs predicts the response of the female cricket to the male's song as the temperature of the female's enclosure varies?

Hint 1. Predicting the outcome of the experiment if your hypothesis is supported

First, review your hypothesis. Your hypothesis states that female crickets respond to both the chirp rate of the male's song *and* the local temperature when identifying potential mates. From this hypothesis, you make the following prediction: If a female cricket is at a different temperature from a male of the same species, she will *not* respond to the male's song. Another way to state this is that a female cricket must be at the same temperature as the male in order to respond to its song.Now think about what this would look like on a graph in which the independent variable (temperature) is plotted on the *x*-axis and the dependent variable (female response) is plotted on the *y*-axis. Remember that the male is kept at 25 °C while the temperature in the female's enclosure varies.

Hint 2. How should a female response appear on the graph?

For this experiment, you devised a scoring system to measure the female response to the male's song. On a scale of 0 to 10, 10 represents the female turning directly toward the singing male and 0 represents no motion or random turning.

Which of the following describes what you would see on the graph if the female responded to the male only when she was at 25 °C?

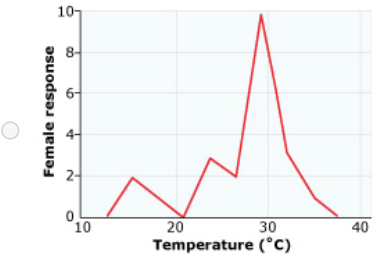
ANSWER:

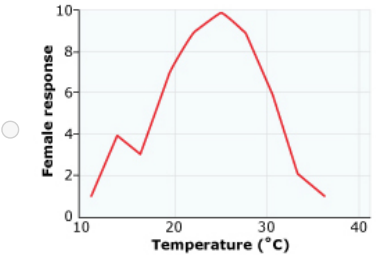
- The plot would spike near 10 at 25 °C.
- The plot would dip near 0 at 25 °C.
- The plot would gradually increase, peaking near 10 at 25 °C, and then gradually decrease.

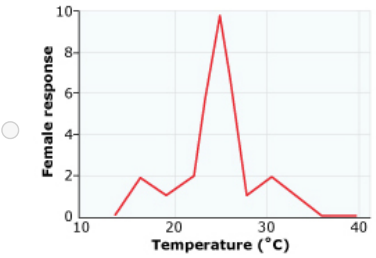
Hint 3. Reviewing independent and dependent variables and how they are graphed

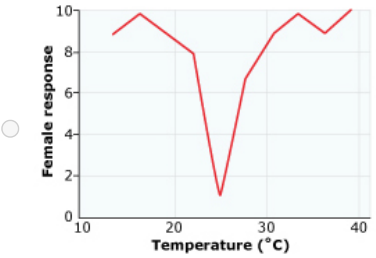
In an experiment, the variable you control is called the independent variable. The variable that changes in response to the independent variable is called the dependent variable. In this experiment, the independent variable is the temperature of the female's enclosure; the dependent variable is the female cricket's response.In a graph, typically, the independent variable is plotted on the *x*-axis, and the dependent variable is plotted on the *y*-axis.

ANSWER:









Misconception Question 4

Part A

Select the correct statement about the process of scientific inquiry.

ANSWER:

- If the results of an experiment do not support the hypothesis that is tested, the experiment is badly designed.
- It is possible to test hypotheses, such as those involving historical events, without conducting experiments.
- The goal of scientific research is to prove the stated hypothesis.

Misconception Question 5

Part A

Which of these examples illustrates deductive reasoning?

ANSWER:

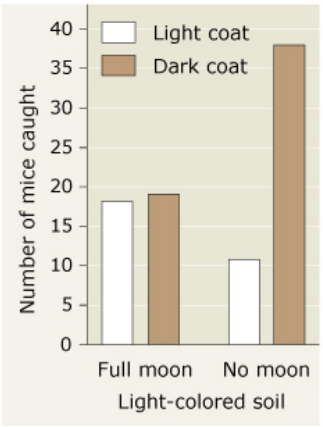
- You and your roommate both drank two cups of coffee before an exam, and both of you got a better than average mark on the exam. You hypothesize that coffee drinking improves academic performance.
- You come down with the flu after you pretended to be sick so you could skip work to attend a concert. Now you decide that fate always punishes you for bad behavior.
- You learned in elementary school that as temperature drops, liquids change into solid form. You are given an unfamiliar liquid and predict that it will become solid if you put it in the freezer.

Scientific Skills Exercise: Interpreting a Pair of Bar Graphs

How much does camouflage affect predation on mice by owls with and without moonlight?

Nearly half a century ago, D. W. Kaufman investigated the effect of prey camouflage on predation. Kaufman tested the hypothesis that the amount of contrast between the coat color of a mouse and the color of its surroundings would affect the rate of nighttime predation by owls. He also hypothesized that the color contrast would be affected by the amount of moonlight. In this exercise, you will analyze data from his owl-mouse predation studies.

Pairs of mice (*Peromyscus polionotus*) with different coat colors, one light brown and one dark brown, were released simultaneously into an enclosure that contained a hungry owl. The researcher recorded the color of the mouse that was first caught by the owl. If the owl did not catch either mouse within 15 minutes, the test was recorded as a zero. The release trials were repeated multiple times in enclosures with either a dark-colored soil surface or a light-colored soil surface. The presence or absence of moonlight during each assay was recorded.



Data from D. W. Kaufman, Adaptive coloration in *Peromyscus polionotus*: Experimental selection by owls, *Journal of Mammalogy* 55:271–283 (1974).

Part A - Understanding the parts of the graph

The graph shows data from the light-colored soil enclosure. There is one dependent variable and more than one independent variable on the graph.

What are the *independent* variables, the variables that were manipulated by the researcher?

ANSWER:

- the color of the soil and the presence or absence of moonlight
- the presence or absence of moonlight and the number of mice caught
- mouse coat color and the number of mice caught
- mouse coat color and the presence or absence of moonlight

Part B

What is the *dependent* variable, the response to the variables being tested?

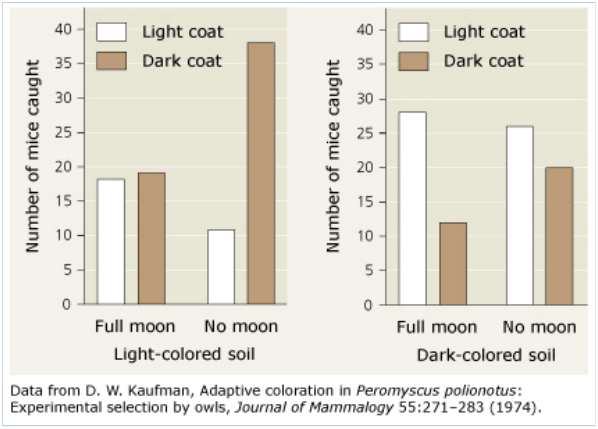
ANSWER:

- the color of the soil
- the number of mice caught
- the mouse coat color
- the presence or absence of moonlight

Part C - Reading the graphs

Select from the dropdown menu above the graph. Now you will look at data from two different enclosures: one with light-colored soil (left), and one with dark-colored soil (right). Use both graphs to answer the next few questions about capture of *dark* brown mice, shown as brown bars in the graphs.

How many dark brown mice were caught in the *light*-colored soil enclosure on a moonlit night?



Data from D. W. Kaufman, Adaptive coloration in *Peromyscus polionotus*: Experimental selection by owls, *Journal of Mammalogy* 55:271–283 (1974).

ANSWER:

- 12
- 17
- 19
- 37

Part D

How many dark brown mice were caught in the *dark*-colored soil enclosure on a moonlit night?

ANSWER:

- 12
- 20
- 28
- 37

Part E - Interpreting the graphs

The bars on the graphs show the numbers of mice that were caught, but keep in mind that mice that were not caught by the owl escaped predation.

On a moonlit night, would a dark brown mouse be more likely to escape predation by owls on dark- or light-colored soil? What data support your conclusion?

ANSWER:

- On dark-colored soil; fewer light brown mice than dark brown mice were caught on light soil under no moon.
- On dark-colored soil; fewer dark brown mice were caught on dark soil than on light soil under a full moon.
- On light-colored soil; fewer dark brown mice were caught on dark soil than on light soil under a full moon.
- On light-colored soil; the lowest level of predation was light brown mice on light soil.

Part F

Is a dark brown mouse on dark-colored soil more likely to escape predation under a full moon or with no moon? What data support your answer?

ANSWER:

- Under no moon; the owl caught more dark mice when there was no moon (about 20) than when there was a full moon (about 12).
- Under a full moon; the owl caught more dark mice when there was no moon (about 37) than when there was a full moon (about 19).
- Under no moon; the owl caught more light mice when there was a full moon (about 17) than when there was no moon (about 11).
- Under a full moon; the owl caught more dark mice when there was no moon (about 20) than when there was a full moon (about 12).

Part G

Under which conditions would a dark brown mouse be most likely to escape predation at night?

ANSWER:

- on dark-colored soil with no moon
- on light-colored soil with no moon
- on light-colored soil with full moon light
- on dark-colored soil with full moon light

Part H

Now take a look at the data on both graphs for *light* brown mice, shown as white bars on the graphs.

How many light brown mice were caught in the *light*-colored soil enclosure on a moonlit night?

ANSWER:

- 11
- 18
- 26
- 28

Part I

How many light brown mice were caught in the *dark*-colored soil enclosure on a moonlit night?

ANSWER:

- 12
- 18
- 26
- 28

Part J

On a moonlit night, would a light brown mouse be more likely to escape predation by owls on dark- or light-colored soil? What data support your conclusion?

ANSWER:

- On light-colored soil; fewer light brown mice were caught on light soil than on dark soil under a full moon.
- On dark-colored soil; fewer dark brown mice were caught on dark soil than on light soil under a full moon.
- On light-colored soil; fewer light brown mice were caught under no moon than under a full moon.
- On dark-colored soil; fewer light brown mice were caught on dark soil than on light soil under a full moon.

Part K

Is a light brown mouse on light-colored soil more likely to escape predation under a full moon or with no moon? What data support your answer?

ANSWER:

- Under no moon; the owl caught more light mice when there was a full moon (about 28) than when there was no moon (about 26).
- Under a full moon; the owl caught more dark mice when there was no moon (about 20) than when there was a full moon (about 12).
- Under no moon; the owl caught more light mice when there was a full moon (about 18) than when there was no moon (about 11).
- Under a full moon; the owl caught more dark mice when there was no moon (about 37) than when there was a full moon (about 19).

Part L

Under which conditions would a light brown mouse be most likely to escape predation at night?

ANSWER:

- on light-colored soil with no moon
- on dark-colored soil with no moon
- on light-colored soil with full moon light
- on dark-colored soil with full moon light

Part M

So far you've looked at each color of mice separately. Next, consider the two colors of mice together when looking at the graphs.

What combination of independent variables led to the highest predation level in enclosures with *light*-colored soil?

ANSWER:

- dark brown coat with full moon
- light brown coat with no moon
- light brown coat with full moon
- dark brown coat with no moon

Part N

What combination of independent variables led to the highest predation level in enclosures with *dark*-colored soil?

ANSWER:

- dark brown coat with no moon
- light brown coat with full moon
- dark brown coat with full moon
- light brown coat with no moon

Part O

Based on both graphs, what condition(s) are most deadly for *both* colors of mice?

ANSWER:

- high contrast between the mouse and its background
- no moonlight
- full moonlight
- dark-colored soil

Part P

Now think about the data from the viewpoint of the owl's hunting success.

Combining the data shown in both graphs, estimate the total number of mice caught in moonlight versus no-moonlight conditions.

ANSWER:

- moonlight: about 77 caught; no moonlight: about 95 caught
- moonlight: about 86 caught; no moonlight: about 86 caught
- moonlight: about 95 caught; no moonlight: about 77 caught
- moonlight: about 83 caught; no moonlight: about 89 caught

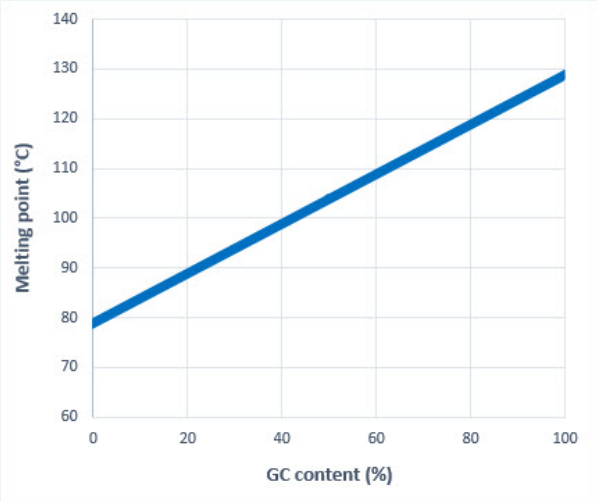
Part Q

Which condition is optimal for predation by the owl on mice?

ANSWER:

- Dark nights are better for hunting.
- Moonlit nights are better for hunting.
- The moon light has no effect on predation success.

Math Practice: Applying Linear Equations to Biological Data



The graph shown here depicts the relationship between the nucleotide composition of a DNA molecule and the temperature at which the DNA molecule denatures (unwinds). The composition of the DNA is measured as the percentage of guanine and cytosine nucleotides (% GC). The temperature at which the DNA denatures is called the melting point.

Part A

Which of the following statements about the graph are true? Select all that apply.

ANSWER:

- [ ] Melting point is on the *x*-axis, and GC content is on the *y*-axis.
- [ ] Melting point is on the *y*-axis, and GC content is on the *x*-axis.
- [ ] As GC content increases, the melting point *increases* at a constant rate.
- [ ] As GC content increases, the melting point *decreases* at a constant rate.
- [ ] The graph shows a linear relationship between GC content and melting point.
- [ ] The graph shows an exponential relationship between GC content and melting point.

Part B

An important property of a linear graph is the slope of the graph line. The slope is a value that indicates the steepness of the line, as well as whether the line slants uphill or downhill. A slope with a positive value slants uphill as you move from left to right across the graph. A slope with a negative value slants downhill as you move from left to right across the graph.

The slope is the ratio of the rise of the line to the run of the line. It can be expressed algebraically like this: $m = \frac{y_2 - y_1}{x_2 - x_1}$ where (x_1, y_1) and (x_2, y_2) are the coordinates of two points on the line.

What is the approximate slope (*m*) of this line? (For practice finding the slope of a line, try this activity.)

ANSWER:

- ( ) 0
- ( ) 0.5
- ( ) 1
- ( ) 1.5

Part C

A straight line between two variables, *x* and *y*, can be represented by this mathematical equation: $y = mx + b$. In this equation, *m* is the slope of the line and *b* is the y-intercept (the point at which the straight line crosses the *y*-axis).

In this graph, what is the y-intercept? (For practice finding the y-intercept of a line, try this activity.)

ANSWER:

- ( ) 0
- ( ) 70
- ( ) 79
- ( ) 120

Part D

Keep in mind that a straight line between two variables can be expressed as $y = mx + b$, where *m* is the slope of the line and *b* is the y-intercept.

Which equation correctly expresses the line in the graph?

ANSWER:

- ( ) $79y = x + 0.5$
- ( ) $y = 0.5x + 79$
- ( ) $y = 79x + 0.5$
- ( ) $0.5y = x + 79$

Part E

Using the equation of the line ($y = 0.5x + 79$), what would be the melting point of DNA with 50% GC content? Enter your answer as a whole number.

ANSWER:

[ ] °C

Part F

Now suppose you encounter three alien species with different genetic material from living things on Earth. The linear relationships between their genetic material composition and melting point can be expressed by the following equations.

- $y = 3x + 25$
- $y = -6x + 12$
- $y = 1.5x + 17$

Drag the correct equation to match each description. The equations may be used once, more than once, or not at all.

ANSWER:

Reset Help

$y = -6x + 12$

$y = 3x + 25$

$y = 1.5x + 17$

1. This equation represents the steepest line. [ ]

2. This equation represents a line that slopes *down* to the right. [ ]

3. Of the two equations that slope *up* to the right, this equation would cross the *y*-axis closer to the origin. [ ]

4. When $x = 4$ in this equation, $y = 37$. [ ]

Math Practice: Generating a Regression Line for Biological Data

Nest	Average clutch size (number of eggs laid)	Proportion of chicks that survived to the following year
1	3.0	0.80
2	2.5	0.85
3	3.8	0.60
4	4.0	0.58
5	2.0	0.90
6	3.9	0.58
7	5.9	0.42
8	3.0	0.79
9	4.3	0.50
10	3.5	0.57

Researchers studying a species of endangered bird were interested in whether a relationship exists between the number of eggs laid by the mother bird at one time and the proportion of chicks surviving to the following year.

The data shown here were collected from 10 different nests in a wild population.

Part A

Your first step is to plot the data.

Which variable would you put on the *x*-axis, and which variable would you put on the *y*-axis?

ANSWER:

- ○ *x*-axis: chick survival
y-axis: clutch size
- ○ *x*-axis: clutch size
y-axis: chick survival
- ○ *x*-axis: nest number
y-axis: chick survival
- ○ *x*-axis: clutch size
y-axis: nest number

Part B

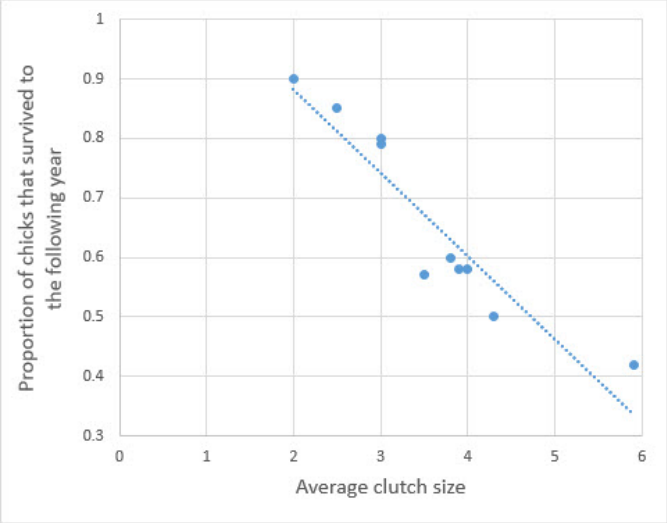
Which type of graph is best suited to this data?

ANSWER:

- pie graph
- scatter plot
- line graph
- bar graph

Part C

Now suppose you plotted the data using a graphing program. Your scatter plot would look similar to this.



Each point represents the data collected from one nest. The line is called a regression line (also called a trend line or best-fit line).

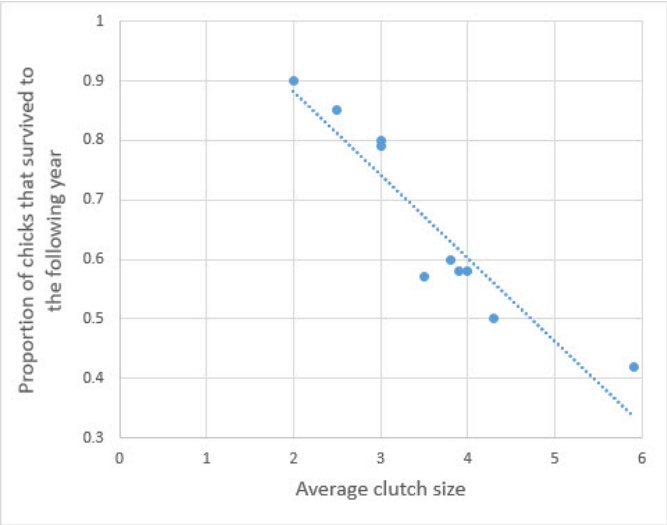
From looking at this scatter plot, what do you think the regression line represents?

ANSWER:

- It represents the straight line that the data would never hit.
- It represents the straight line that runs through the most data points.
- It represents the straight line that fits most closely the trend in the data.
- It represents the straight line that the data should have followed.

Part D

The equation of the regression line can be expressed in this format: $y = mx + b$. In this equation, m is the slope of the line and b is the y-intercept. When a graphing program plots a regression line, it carries out calculations with the raw data to determine the equation of the line.



Which equation most closely approximates the regression line shown in the graph? (For practice approximating the equation of a line, try this activity.)

ANSWER:

- $y = -0.14x + 1.2$
- $y = -1.2x + 7$
- $y = 7x + 1.2$
- $y = 0.14x + 1.2$

Part E

The equation of a regression line can be used to calculate the value of y expected for a particular value of x.

What would be the approximate survival rate for a nest with 5 eggs?

ANSWER:

- 0.25
- 0.50
- 0.65
- 0.75

Part F

A statistical measure of how closely data fit a linear relationship is called the correlation coefficient (r). The value of the correlation coefficient can range between –1 and 1.

- When $r > 0$, y and x are positively correlated (y becomes larger as x becomes larger).
- When $r < 0$, y and x are negatively correlated (y becomes smaller as x becomes larger).

The closer r is to either extreme of the range (–1 or 1), the stronger the linear relationship between the variables.

- When $r = 1$, all data points fall on the regression line in a perfect positive correlation.
- When $r = –1$, all data points fall on the regression line in a perfect negative correlation.
- As the value of r approaches 0, the data points display more scatter, indicating a weaker linear relationship.
- When $r = 0$, the variables do not have a linear relationship.

The correlation coefficient of the data on chick survival vs. clutch size is –0.93. How would you interpret that correlation coefficient?

ANSWER:

- Chick survival and clutch size are strongly positively correlated.
- Chick survival and clutch size are weakly positively correlated.
- Chick survival and clutch size are strongly negatively correlated.
- Chick survival and clutch size are weakly negatively correlated.

Part G

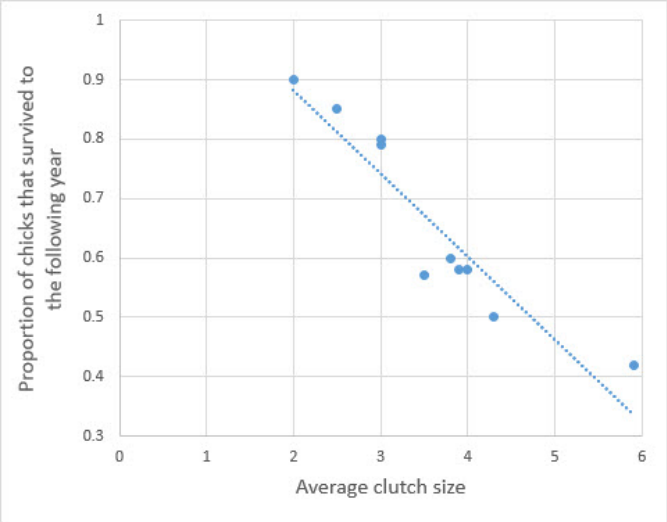
Suppose you analyzed the same type of data for a different species and found a correlation coefficient of –0.17. How would you describe the relationship between chick survival and clutch size for that species?

ANSWER:

- ○ Chick survival and clutch size are weakly negatively correlated.
- ○ Chick survival and clutch size are strongly positively correlated.
- ○ Chick survival and clutch size are strongly negatively correlated.
- ○ Chick survival and clutch size are weakly positively correlated.

Part H

Here is the scatter plot again.



What can you conclude from the graph? Select all that apply.

ANSWER:

- ☐ Large clutch size causes lower chick survival.
- ☐ Smaller clutch sizes increase the parents' fitness.
- ☐ Higher clutch sizes increase the parents' fitness.
- ☐ Higher chick survival leads to smaller clutch sizes.
- ☐ Large clutch size is strongly correlated with lower chick survival.

Scientific Thinking: Testing the Safety of Bisphenol A

Bisphenol A (often called BPA) is a chemical found in products that people use every day, from water bottles to food containers to children's toys. Unfortunately, BPA leaches out of its many products and makes its way into our bodies. What are the health effects of BPA exposure? Ongoing research is finding that elevated exposure to BPA can affect a wide variety of developmental and physiological processes, but one of the first studies of BPA's health effects came about because of a simple mistake in the lab.

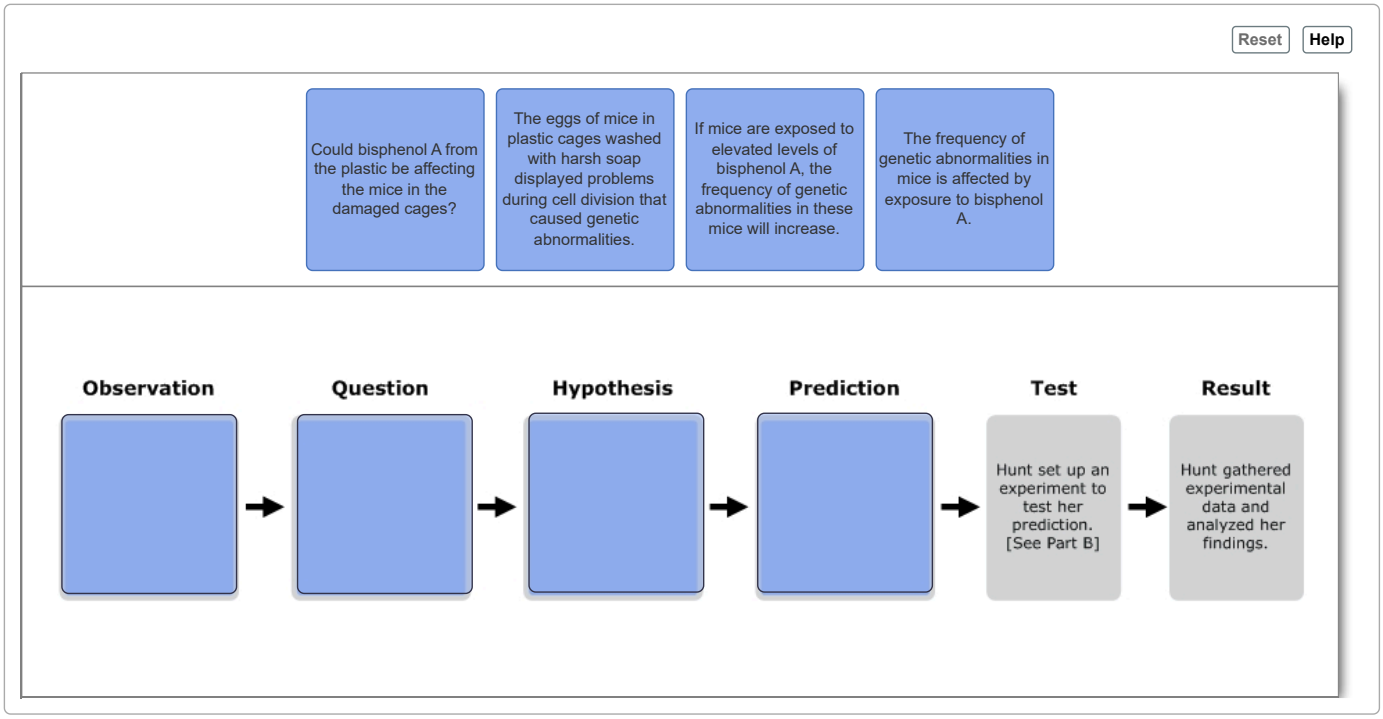
At a laboratory at Case Western Reserve University in 1998, geneticist Patricia Hunt was making a routine check of her female lab mice. As she extracted and examined developing eggs from the ovaries, she began to wonder what had gone wrong. She noticed that many of the eggs showed problems with their chromosomes, and some had irregular amounts of genetic material, which can lead to miscarriages and birth defects in mammals. She learned that a lab assistant had mistakenly washed the plastic mouse cages and water bottles with a harsh soap, releasing BPA from the plastic. Knowing that BPA is an endocrine disruptor, a chemical that can enter organisms and mimic hormones, Hunt set out to discover whether it had adversely affected her mice.

Part A - Scientific method: Developing a hypothesis

Can you identify the steps in the scientific method that correspond to Hunt's experiments?

Drag each statement under the step in the scientific method that it demonstrates.

ANSWER:

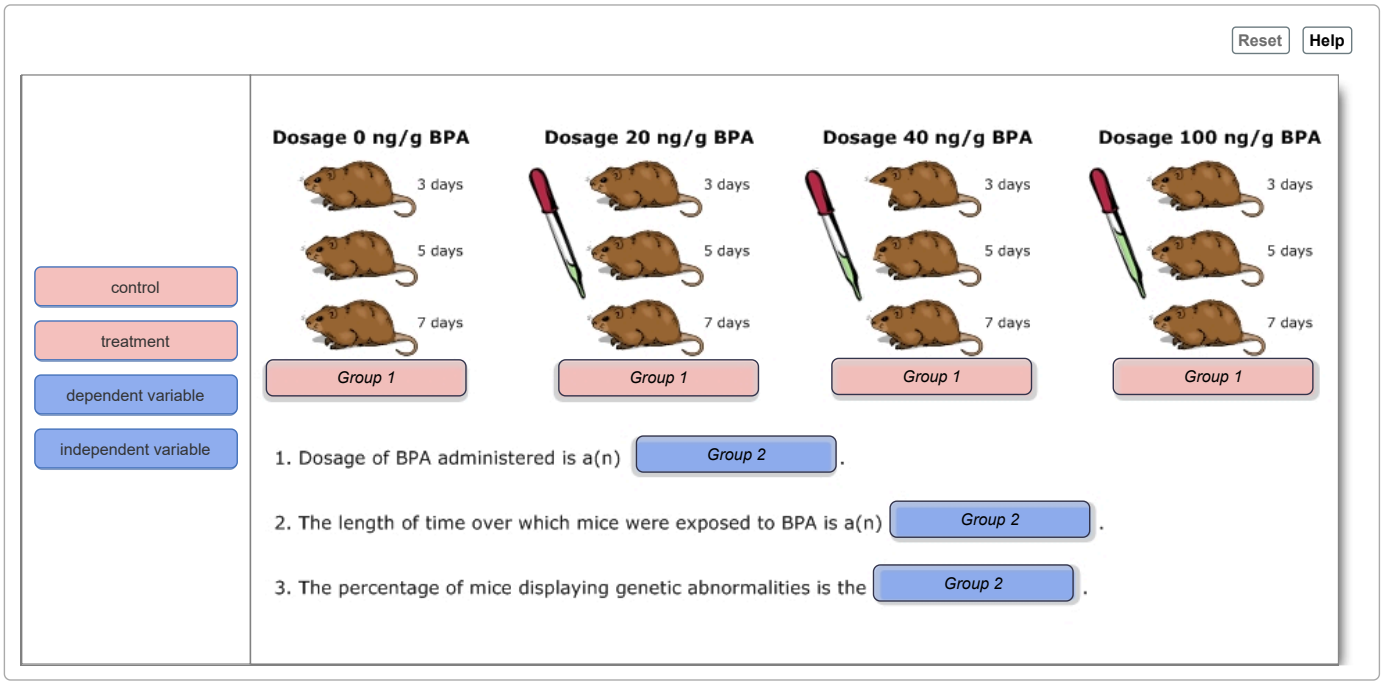


Part B - Experimental design: Identifying variables

Hunt and her team designed an experiment to test her hypothesis about the effect of BPA on mice. They administered daily doses of BPA to groups of female mice over three, five, or seven days and then tested these mice for genetic abnormalities that occur during meiosis, the division of chromosomes during egg formation.

Drag the labels to identify the components of Hunt's experiment. Labels may be used once, more than once, or not at all.

ANSWER:



Part C - Types of experiments: Natural and manipulative

Experiments in environmental toxicology can sometimes be manipulative experiments in which the researcher actively chooses and manipulates the independent variable. In Hunt's study, for example, dosages of BPA were manipulated and the effects were measured. In manipulative studies, the researcher controls all the other variables in the experiment, so any health effects observed in the test subjects can be attributed to differences in the independent variable.

In other cases, researchers use natural experiments in which the dependent variable (typically a measure of organism health) is measured under differing contexts that are not manipulated. Say, for example, that an accidental chemical spill contaminates five ponds. To determine the possible effects of the toxic chemical on frogs, a researcher could compare the hatching rate of frog eggs laid in those five ponds to the hatching rate of eggs laid in five uncontaminated ponds nearby. This would be an example of a natural experiment because concentrations of the toxic chemical in the ponds were not controlled by the experimenter, but rather resulted from the chemical spill.

Drag type of experiment on the left to the example of experiment on the right.

ANSWER:

Reset Help

Natural

Manipulative

1. [ ] : Blood concentrations of BPA in college students are compared to their recent consumption of canned food items.

2. [ ] : The feeding behavior of fish in streams that receive acidic runoff from strip mines is compared to the feeding behavior of fish in unaffected streams.

3. [ ] : The deformity rate in baby birds from nests in pesticide-sprayed fields is compared to the deformity rate in birds from nests in unsprayed fields.

4. [ ] : Tumor development is compared in mice exposed to five dosages of a known carcinogen in the laboratory.

5. [ ] : Foraging activity levels are compared in tadpoles exposed to four concentrations of toxic metals in the laboratory.

6. [ ] : Growth of corn plants is compared in field plots sprayed with three different dosages of weed killer.

7. [ ] : BPA concentrations in the urine of people with diabetes are compared to BPA concentrations in the urine of people without diabetes.

Scientific Thinking: What Role Does Peer Review Play in the Process of Science?

Imagine that you are a scientist hard at work in a cancer research lab. You and many of your colleagues are hoping to discover new powerful drugs that could prevent deaths from cancer.

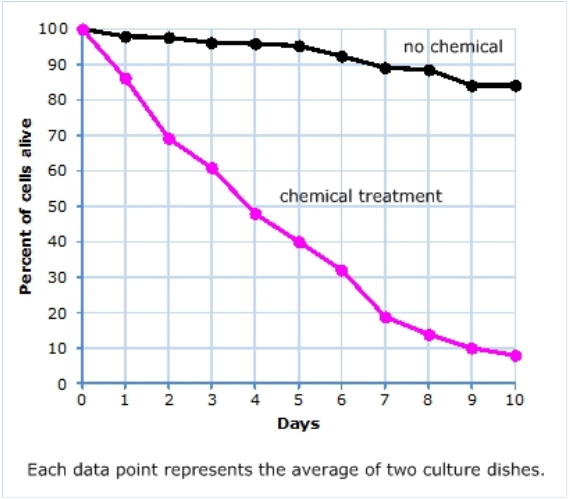
Your research team has observed that cancer cells have a lower survival rate when exposed to samples of a certain species of fungus. To study this further, your team isolated several chemicals from the fungus, including one known to affect cell metabolism. You hypothesize that it is that chemical that lowers the survival rate of cancer cells.

Part A - Interpreting graphs

Based on your hypothesis, you predict that the chemical isolated from the fungus will successfully kill cancer cells. To test this prediction, you design the following experiment.

- You isolate cancerous cells from the colon of a patient from North Carolina and culture (grow) the cells in your lab.
- You divide the cultured cells into four separate culture dishes. You treat two of the dishes with the fungus chemical and the other two with a control solution that does not contain the chemical.
- Over the next ten days, you collect data on the percentage of cells that remain alive in each culture dish.

This graph displays the data you collected.



Each data point represents the average of two culture dishes.

Determine which statements are supported by the data in the graph. Drag each statement into the appropriate bin.

ANSWER:

Reset Help

Cancer cells treated with the chemical have a *lower* survival rate than cells that are not treated.

Cancer cells treated with the chemical have a *higher* survival rate than cells that are not treated.

This chemical will be useful for treating colon cancer, but not necessarily for other types of cancers.

This chemical will be useful for treating all types of cancers.

After 5 days of chemical treatment, less than 50% of the cancer cells are alive.

After 10 days without chemical treatment, more than 90% of the cancer cells are alive.

Statement(s) supported by the data	Statement(s) NOT supported by the data

Part B - Evaluating experimental design

Excited about the fungus chemical's promise for treating cancer, you write up your experimental results and send the paper to a prestigious scientific journal, hoping it will be published. The journal sends your paper out to several scientists for evaluation--a process known as peer review.

The reviewers identify several issues with the experimental design and data presented in your paper. Which of the following criticisms are valid issues of concern that peer reviewers might identify?

Select all that apply.

ANSWER:

- [ ] The experiment should have been run for more days in order to make the effect of the fungus chemical clearer.
- [ ] The treatment kills cancer cells, but it might simply be a poison that kills all cells—even normal cells.
- [ ] The effect may not be real because we don't know if the results are reproducible.
- [ ] Cell samples were taken from too few patients.
- [ ] There was no control in the experiment.

Part C - Making predictions

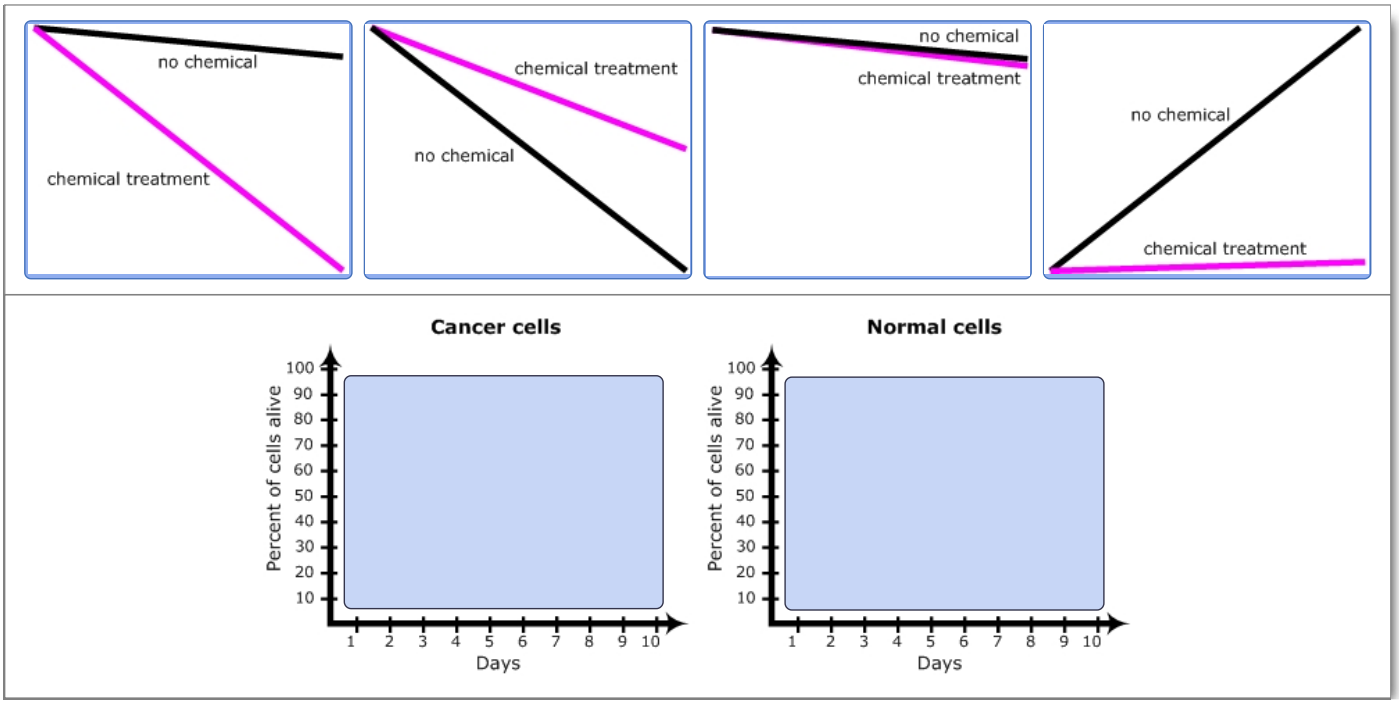
The reviewers suggested that you think more carefully about your hypothesis and experimental design. For a chemical to make a good cancer treatment, it is not enough that it harms cancer cells. The chemical needs to have a selective effect on cancer cells--that is, it needs to harm cancer cells much more than it harms normal (noncancerous) cells.

You decide to run a new experiment to test the hypothesis that the fungus chemical harms cancer cells selectively. In this controlled experiment, you will test both cancer cells and normal cells under identical conditions. What data would support this hypothesis?

Predict the expected results for cancer cells and normal cells by choosing the correct graph lines and dragging them onto the two graphs.

ANSWER:

Reset Help



Chapter 1 Question 4

Part A

A controlled experiment is one that

ANSWER:

- keeps all variables constant.
- tests experimental and control groups in parallel.
- proceeds slowly so a scientist can make careful records.
- is repeated many times to make sure the results are accurate.

Chapter 1 Question 5

Part A

Which of the following statements best distinguishes hypotheses from theories in science?

ANSWER:

- Theories are proved true; hypotheses are often contradicted by experimental results.
- Theories are hypotheses that have been proved.
- Hypotheses usually are relatively narrow in scope; theories have broad explanatory power.
- Hypotheses are guesses; theories are correct answers.

Chapter 1 Question 6

Part A

Which of the following is an example of qualitative data?

ANSWER:

- The temperature decreased from $20^{\circ}\mathrm{C}$ to $15^{\circ}\mathrm{C}$.
- The fish swam in a zigzag motion.
- The six pairs of robins hatched an average of three chicks each.
- The contents of the stomach are mixed every 20 seconds.

Chapter 1 Question 7

Part A

Which sentence best describes the logic of scientific inquiry?

ANSWER:

- If I generate a testable hypothesis, tests and observations will support it.
- If my prediction turns out to be correct, my hypothesis is supported.
- If my observations are accurate, they will support my hypothesis.
- If my prediction is correct, it will lead to a testable hypothesis.

Chapter 1 Pre-Test Question 9

Part A

In order for a hypothesis to be able to be used in science, which of the following must be true?

You did not open hints for this part.

ANSWER:

- it must be reproducible
- it must be popularly accepted
- it represents established facts
- it is testable and falsifiable
- it must be proven correct

Chapter 1 Pre-Test Question 10

Part A

Which of the following is true of a scientific theory?

You did not open hints for this part.

ANSWER:

- it is a method or device that applies scientific knowledge for some specific purpose
- it generates testable hypotheses, is supported by a large body of evidence, and is broad in scope
- it is formulated by many scientists over drinks at a scientific convention
- it is only accepted after the person who came up with it has died
- it must demonstrate the effect of one variable by testing control groups and experimental groups

Chapter 1 Question 28

Part A

Agrobacterium infects plants and causes them to form tumors. You are asked to determine how long a plant must be exposed to these bacteria to become infected. Which of the following experiments will provide the best data to address that question?

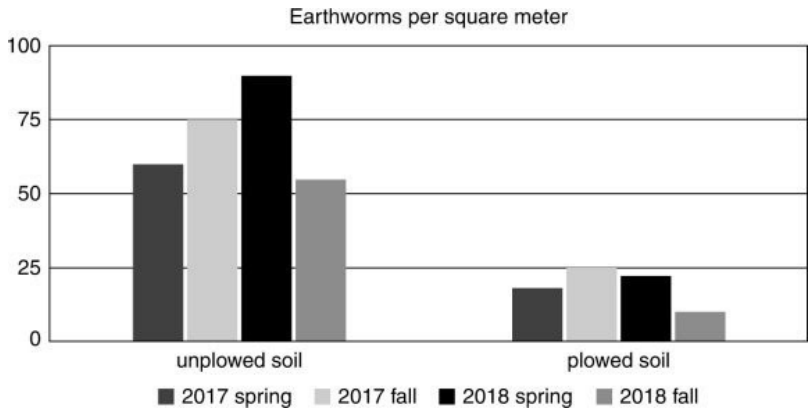
ANSWER:

- Determine the survival rate of *Agrobacterium* when exposed to different concentrations of an antibiotic.
- Measure the concentration of *Agrobacterium* in different soil environments where the plants grow.
- Measure the number of tumors formed on a plant when exposed to various concentrations of *Agrobacterium.*
- Measure the number of tumors formed on plants, which are exposed to *Agrobacterium* for different lengths of time.

Chapter 1 Question 25

Part A

Use the information in the graph to answer the following question.



Which of the following claims is best supported using the graph?

ANSWER:

- Plowed soil contains more earthworms than unplowed soil.
- Plowing has no effect on the number of earthworms in the soil.
- Unplowed soil contains more earthworms than plowed soil.
- More earthworms are found in the soil in spring than in fall.

Chapter 1 Question 34

Part A

Which of the following is the quality of a good scientific hypothesis?

ANSWER:

- It always produces quantitative data
- It should be testable in a valid period of time
- It relies on controversial factors
- It always produces qualitative data

Chapter 1 Question 33

Part A

Which of the following best describes a controlled experiment?

ANSWER:

- An experiment that includes one group for which the scientist controls all variables
- An experiment that includes at least two groups, one differing from the other by two or more variables
- An experiment repeated many times to ensure that the results are accurate
- An experiment includes at least two groups, one of which does not receive the experimental treatment

Chapter 1 Question 36

Part A

In an experiment to test the hypothesis, "temperature controls sex determination in crocodile embryos" a researcher incubates crocodile eggs in incubators set at different temperatures. Which of the following correctly identifies the dependent and independent variables in the experiment?

ANSWER:

- temperature is dependent, sex is independent
- temperature is dependent, type of incubator is independent
- sex is dependent, temperature is independent
- type of incubator is dependent, temperature is independent

Chapter 1 Question 23

Part A

Following a scientific method, which of the following is the correct order of steps?

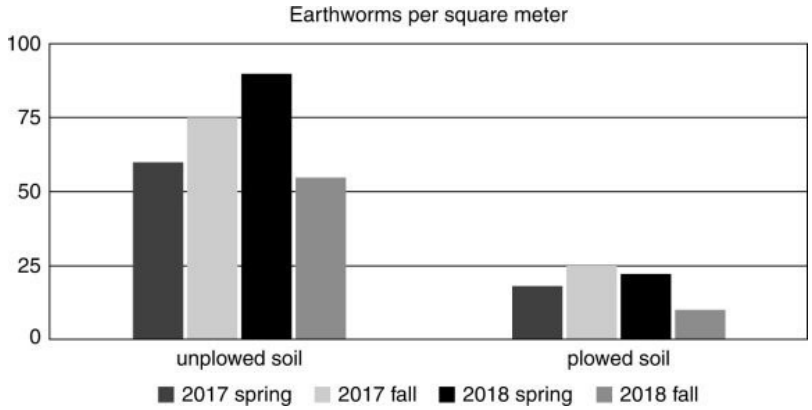
ANSWER:

- Observation → Hypothesis → Experiment → Analysis → Conclusion → Communicate results
- Observation → Analysis → Hypothesis → Conclusion → Communicate results → Experiment
- Experiment → Hypothesis → Observation → Analysis → Conclusion → Communicate results
- Observation → Hypothesis → Experiment → Communicate results → Analysis → Conclusion

Chapter 1 Question 26

Part A

Use the information in the graph to answer the following question.



Based on the bar graph, which season, year, and soil condition were the worst for cultivating earthworms?

ANSWER:

- spring 2017, plowed soil
- fall 2018, plowed soil
- fall 2018, unplowed soil
- spring 2017, unplowed soil

Chapter 1 Question 32

Part A

Which of the following instructions contribute to a productive experimental design?

ANSWER:

- do not run the experiment more than once, the results might become confusing
- do not include a control, it is a waste of resources.
- include a small sample size
- alter only one condition between the control and the experimental condition

Chapter 1 Question 35

Part A

In presenting data that result from an experiment, a group of students shows that most of their measurements fall on a straight diagonal line on their graph. However, two of their data points are "outliers" and fall far to one side of the expected relationship. Which of the following is the most reasonable way to handle the outliers when analyzing the data?

ANSWER:

- Show all results obtained and then try to explore the reason(s) for the variation in data.
- Change the details of the experiment until they can obtain the expected results.
- Average several trials, rule out the improbable results, and do not show them in the final work.
- Do not show these points because clearly something went wrong in the experiment.

Chapter 1 Question 37

Part A

Which of these is an example of inductive reasoning?

ANSWER:

- If protists are all single-celled, then they are incapable of aggregating.
- If two species are members of the same genus, they are more alike than each of them could be to a different genus.
- Hundreds of individuals of a species have been observed and all are photosynthetic; therefore, the species is photosynthetic.
- These organisms live in sunny regions. Therefore, they are using photosynthesis.

Chapter 1 Question 30

Part A

Use the following information when answering the following question.
In 1668, Francesco Redi performed a series of experiments on spontaneous generation. He began by putting similar pieces of meat into eight identical jars. Four jars were left open to the air, and four were sealed. He then did the same experiment with one variation: Instead of sealing four of the jars completely, he covered them with gauze (the gauze excluded the flies while allowing the meat to be exposed to air). In both experiments, he monitored the jars and recorded whether or not maggots (young flies) appeared in the meat.
What hypothesis was being tested in the initial experiment with open versus sealed jars?

ANSWER:

- Maggots do not arise spontaneously, but from eggs laid by adult flies.
- Spontaneous generation is more likely during the long days of summer.
- Spontaneous generation can occur only if meat is exposed to air.
- The type of meat used affects the likelihood of spontaneous generation.

Chapter 1 Question 29

Part A

Agrobacterium infects plants and causes them to form tumors. Tumor formation requires a large amount of the plant's energy for tissue formation. What could be the possible impact of tumor formation on plant reproduction? And why?

ANSWER:

- The number of offspring should increase because in general, illness increases the reproductive output of organisms.
- There should be no effect of infection on offspring production because energy for reproduction is independent of infection.
- The number of offspring should decrease because the plant will divert energy from reproduction to tumor formation.
- The number of offspring should increase because the bacteria will provide energy for the plant.

Chapter 1 Question 22

Part A

Cotton-topped tamarins are small primates with tufts of long white hair on their heads. While studying these creatures, researchers noticed that males with longer hair get more opportunities to mate and father more offspring. Which of the following research questions would best test the hypothesis that having longer hair is adaptive in these males?

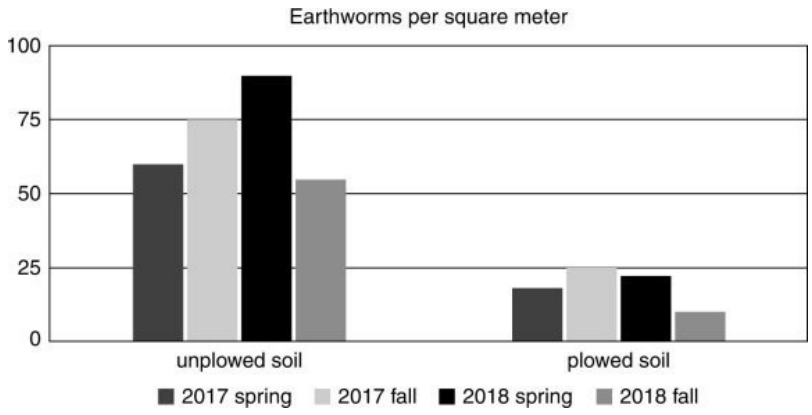
ANSWER:

- test whether other traits in these males are also adaptive
- determine if hair length is heritable
- look for evidence of hair in ancestors of tamarins
- test whether males with shaved heads are still able to mate

Chapter 1 Question 24

Part A

Use the information in the graph to answer the following question.



The data can best be used to address which of the following question?

ANSWER:

- What is the impact of plowing soil on the number of earthworms?
- Does season has an impact on the size of the earthworms?
- What is the impact of plowing on the speed of growth of the earthworms?
- Does plowing have an impact on the size of the earthworms?

Chapter 1 Question 27

Part A

How does a scientific theory differ from a scientific hypothesis?

ANSWER:

- Theories are usually an explanation for a more general phenomenon; hypotheses typically address more specific issues.
- Theories are proposed to test scientific hypotheses.
- Hypotheses are usually an explanation for a more general phenomenon; theories typically address more specific issues.
- Confirmed theories become scientific laws; hypotheses become theories.

Chapter 1 Question 31

Part A

Use the following information when answering the following question.
In 1668, Francesco Redi performed a series of experiments on spontaneous generation. He began by putting similar pieces of meat into eight identical jars. Four jars were left open to the air, and four were sealed. He then did the same experiment with one variation: Instead of sealing four of the jars completely, he covered them with gauze (the gauze excluded the flies while allowing the meat to be exposed to air). In both experiments, he monitored the jars and recorded whether or not maggots (young flies) appeared in the meat.
In both experiments, flies appeared in all of the open jars and only in the open jars. Which one of the following statements is correct?

ANSWER:

- The experiment was inconclusive because it did not run long enough.
- The experiment was inconclusive because Redi used only one kind of meat.
- The experiment supports the hypothesis that maggots arise only from eggs laid by adult flies.
- The experiment supports the hypothesis that spontaneous generation occurs in rotting meat.

Activity: Science, Technology, and Society: DDT

Launch the Science, Technology, and Society: DDT Activity and answer the questions.

Part A

In animal populations, DDT causes _____.

ANSWER:

- birth defects
- tuberculosis
- sleeping sickness
- the flu
- malaria

Part B

DDT is _____-soluble so it accumulates in _____.

ANSWER:

- fat ... milk
- water ... milk
- water ... streams
- fat ... streams
- water ... oceans

Part C

Which one of the following statements is true?

ANSWER:

- DDT does not help prevent disease from passing from agricultural animals to humans.
- Cost was a major factor in the United States government's decision to ban DDT.
- Many African governments concluded that the potential long-term health effects of DDT were not as serious as the immediate problem of insect control.
- DDT cannot accumulate in the fat of animals.
- The DDT ban in the United States has made it very difficult to control agricultural insect pests.

Building Vocabulary: Word Roots - Metric Prefixes

Knowing the meaning of common prefixes, suffixes, and word roots can help you understand biology terms.

Part A

Can you match these prefixes, suffixes, and word roots with their definitions?

ANSWER:

Reset Help

hecto-	measure:
milli-	large:
***metr-* (or *-meter*)**	giant:
***deka-* (or *deca-*)**	one thousand (1,000):
centi-	one hundred (100):
giga-	ten (10):
mega-	one-tenth (1/10):
kilo-	one-hundredth (1/100):
micro-	one-thousandth (1/1,000):
deci-	small:

Chapter 1 Question 11

Part A

SCIENTIFIC INQUIRY

Scientists search the scientific literature using electronic databases such as PubMed, a free online database maintained by the National Center for Biotechnology Information. Use PubMed to find the abstract of an article that Hopi Hoekstra published in 2017 or later. Choose the correct articles.

Select the *two* correct answers.

ANSWER:

- [ ] Developmental mechanisms of stripe patterns in rodents
- [ ] The selective glucocorticoid receptor antagonist CORT125281 has tissue-specific activity
- [ ] QnAs with Hopi Hoekstra
- [ ] Coevolution of genome architecture and social behavior
- [ ] Executive functioning and emotion recognition in youth with oppositional defiant disorder and/or conduct disorder
- [ ] The genetic basis of parental care evolution in monogamous mice

Chapter 1 Question 39

Part A

Why is a scientific topic best discussed by people of varying points of view, from different subdisciplines, and representing diverse cultures?

ANSWER:

- ( ) This is a way of ensuring that everyone gets the same results.
- ( ) Scientific theory requires input from different cultures and communities.
- ( ) Scientists can coordinate with others to conduct experiments in similar ways.
- ( ) Robust and critical discussion between diverse groups improves scientific thinking.

Chapter 1 Question 38

Part A

Which of the following best describes a model organism?

ANSWER:

- ( ) It has been chosen for study by early biologists.
- ( ) It is well studied, it is easy to propagate, and results are widely applicable.
- ( ) It is often pictured in textbooks and is easy for students to imagine.
- ( ) It is small, inexpensive to raise, and lives a long time.

Current Events: Should You Keep Taking Those Fish Oil And Vitamin D Pills? (NPR, 11/15/2018)

Read this *NPR* article and then answer the questions.

Should You Keep Taking Those Fish Oil And Vitamin D Pills? (*NPR*, 11/15/2018)

Subscription to *NPR* provides instant access to breaking news with NPR.org. Visit https://www.npr.org/about-npr/471757314/newsletters to subscribe.

Part A

You are a family practitioner. Which of the following patients you see is most likely to need Vitamin D supplements?

ANSWER:

- A man with light skin who spends his winters in Texas.
- A woman with dark brown skin who lives in Michigan.
- A man with olive skin who lives in Florida.
- A woman with light brown skin who works outside year-round.

Part B

Why is milk often fortified with Vitamin D?

ANSWER:

- Vitamin D is associated with magnesium uptake.
- Vitamin D is associated with calcium uptake.
- Vitamin D is associated with iron uptake.
- Vitamin D is associated with protein uptake.

Part C

You are a registered dietician. Which of the following clients is most likely to benefit from taking a fish oil supplement?

ANSWER:

- Everyone
- Someone who eats 2—3 servings of fish per week.
- Someone who rarely eats fish.
- Someone who eats more than 3 servings of fish per week.

Part D

If the results of this study prove correct, taking a fish oil supplement is most likely to benefit which of the following type of person?

ANSWER:

- A person with an increased risk of stroke.
- A person with an increased risk of genetically-linked breast cancer.
- A person with an increased risk of heart attack.
- A person with an increased risk of colon cancer.

Part E

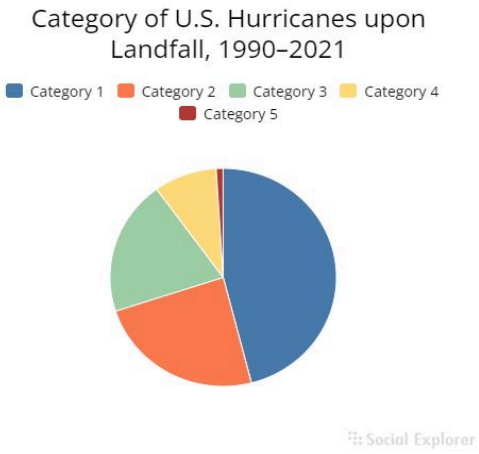
You have your blood tested. The results show that you have adequate levels of Vitamin D. Which of the following would likely be best for you?

ANSWER:

- Take a Vitamin D supplement to reduce your risk of cancer and cardiovascular disease.
- Take a Vitamin D supplement to reduce your risk of cardiovascular disease.
- Take a Vitamin D supplement to reduce your risk of cancer.
- Not take a Vitamin D supplement.

GraphIt!: Introduction to Graphing

Complete the GraphIt! activity. Then answer the following questions.



Part A

You explored terminology related to scientific data and graphing in this GraphIt! activity. A quick review of these terms will prepare you to decide how to graph a data set.

Place the terms in the appropriate blanks to complete the sentences. Not all terms will be used.

ANSWER:

Reset Help

x-axis
line graph
y-axis
trend
bar graph
independent
dependent
inference
scatter plot
pie chart
variable
correlation

1. The variable that is NOT changed by the other variables being measured in the research study or experiment is called the [ ] variable, and it is generally placed on the [ ] of a graph.

2. The variable that may be changed by other variables in the research study or experiment is called the [ ] variable, and it is generally placed on the [ ] of a graph.

3. The type of graph that displays data as a series of points connected by straight line segments is called a [ ]; it is often used to show a [ ], or pattern of data over time.

4. The type of graph that displays data of two or more variables plotted as points along an *x*- and *y*-axis is called a [ ]; it is used to visualize a [ ] between the variables.

5. A conclusion that is reached using evidence and reasoning when examining data or ideas is called a(n) [ ].

Part B

The following graph shows sea level data for Charleston, South Carolina from 1930 to 2020.

Place the terms with their representative components on the graph. Not all labels will be used.

ANSWER:

Reset Help

line graph

dependent variable

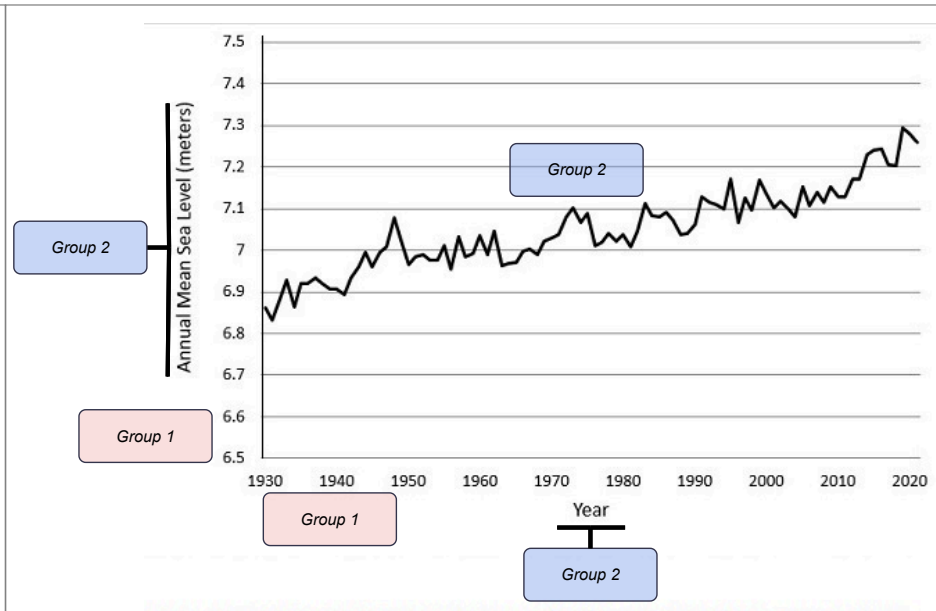
independent variable

scatter plot

pie chart

x-axis

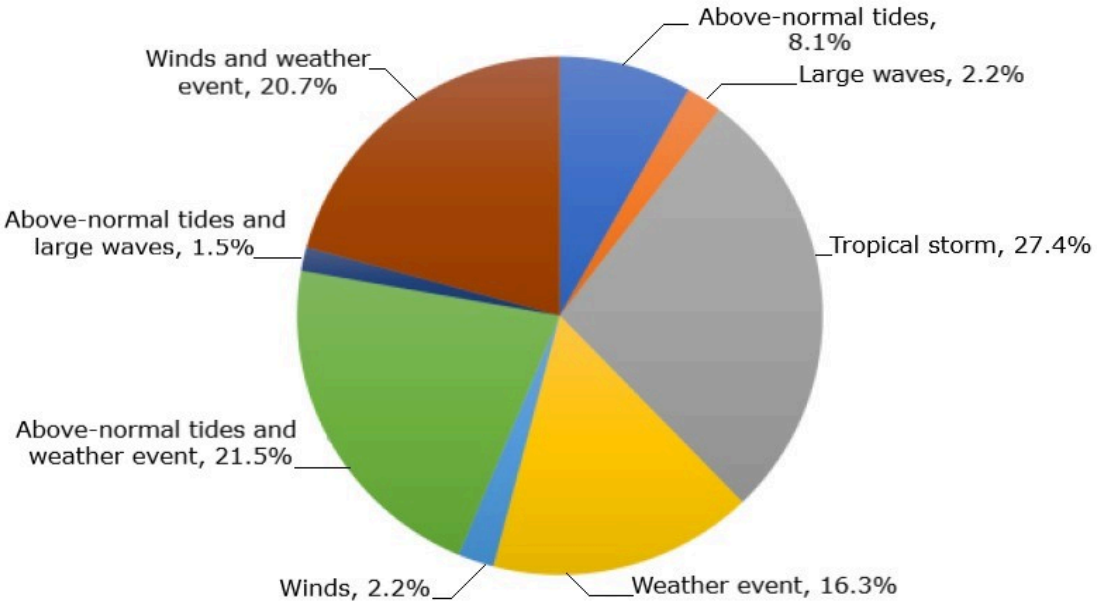
y-axis



Part C

In coastal locations, exceptionally high tides occur a few times a year, with a new or full moon, and when Earth is closest to the sun. These exceptionally high tides are sometimes referred to as "king tides" or "sunny day flooding." When above-normal tides occur at the same time as other coastal events, such as heavy rainfall or strong onshore winds, the tides become even higher.

The following pie chart breaks down the causes of extreme coastal flooding events in the United States in 2021 for 135 coastal locations.



Data from National Oceanic and Atmospheric Administration (NOAA), Center for Operational Oceanographic Products and Services, Top Ten Water Levels, 2021

Rank the following events from least to greatest occurrence.

ANSWER:

Reset Help

Above-normal tides | Above-normal tides and weather event | Tropical storm | Weather event | Winds and weather event

Caused the least coastal flooding				Caused the most coastal flooding

Part D

High tide flood events disrupt the businesses and daily lives of people that live in the area affected by the abnormally high water. With sea level rise and other climatic and weather events, we might ask, "Have high tide flood events become more frequent over time?"

The data presented here is for Charleston, South Carolina. Use this data to answer the question.

Year	Number of High Tide Flood Events	Highest Temperature (°F)	Total annual precipitation (mm)	Annual Mean Sea Level (m)
1980	0	100.0	1039	7.04
1981	3	100.9	1257	7.01
1982	1	96.1	1194	7.05
1983	0	100.0	1374	7.11
1984	1	99.0	1176	7.08
1985	0	100.0	1280	7.08
1986	2	104.0	1229	7.09
1987	2	99.0	1440	7.07
1988	0	100.0	1082	7.04
1989	3	98.1	1425	7.04
1990	0	100.0	1146	7.06
1991	0	98.1	1262	7.13
1992	0	98.1	1369	7.12
1993	1	100.0	1339	7.11
1994	3	95.0	1791	7.10
1995	0	102.0	1257	7.17
1996	1	99.0	1163	7.07
1997	0	97.0	1590	7.13
1998	0	100.0	1720	7.10
1999	3	105.1	1179	7.17
2000	1	100.0	1168	7.14
2001	2	97.0	1016	7.10
2002	2	100.9	1549	7.12
2003	0	95.0	1295	7.10
2004	0	97.0	998	7.08
2005	0	100.0	1173	7.15
2006	0	98.1	1252	7.11
2007	3	99.0	1069	7.14
2008	1	100.0	1201	7.11
2009	4	98.1	1422	7.15
2010	1	99.0	1463	7.13

2011	0	102.0	940	7.13
2012	10	98.1	1118	7.17
2013	0	97.0	1476	7.17
2014	0	99.0	1346	7.23
2015	10	99.0	1902	7.24
2016	7	100.0	1516	7.24
2017	4	98.1	1344	7.21
2018	6	97.0	1466	7.20
2019	14	100.9	1257	7.29
2020	14	97.0	1364	7.28

Data from National Oceanic and Atmospheric Administration (NOAA), Center for Operational Oceanographic Products and Services, Station ID 8665530 Charleston South Carolina; NOAA, National Centers for Environmental Information, Global Summary of the Year (GSOY), Charleston, SC

Place the terms in the appropriate blanks to complete the sentences. Terms may be used once, more than once, or not at all.

ANSWER:

Reset Help

pie chart
line graph
highest temperature
annual mean sea level
total annual precipitation
number of high tide flood events
year
bar graph
scatter plot

1. To answer the question "Have high tide flood events become more frequent over time?" you should compare these two variables from the data set: [ ] and [ ] .

2. To visualize the data to answer the research question, you could use a [ ] or a [ ] .

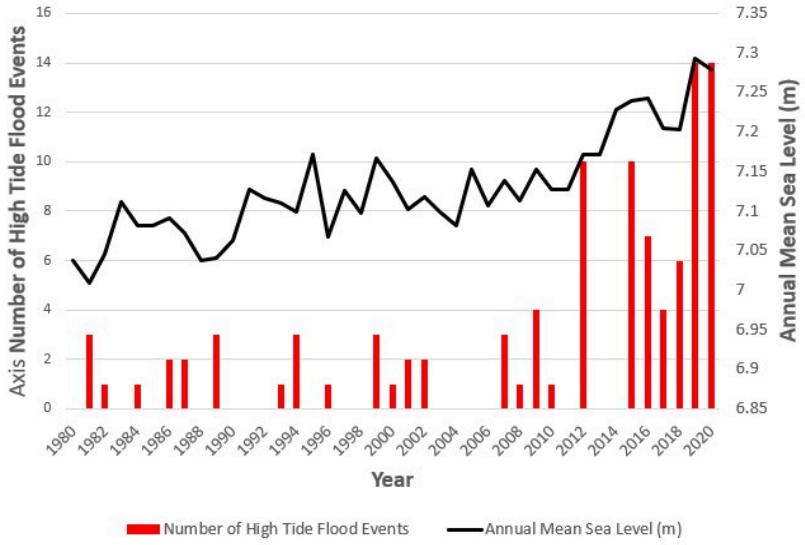
3. In this graph, the independent variable would be [ ] and the dependent variable would be [ ] .

4. If instead you wanted to look for a correlation between sea level rise and flood events, you could use a [ ] .

5. In this plot, you would plot [ ] on one axis and [ ] on the other axis.

Part E

The following graph plots the data you chose in the previous question: number of high tide flood events over time. It also includes a secondary *y*-axis showing sea level change over time at Charleston, South Carolina.



Data from National Oceanic and Atmospheric Administration (NOAA), Center for Operational Oceanographic Products and Services, Station ID 8665530 Charleston South Carolina; NOAA, National Centers for Environmental Information, Global Summary of the Year (GSOY), Charleston, SC

Which inferences can you make from the data in the graph? Select all that apply.

ANSWER:

- [ ] The number of high tide flood events in Charleston increased between 1980 and 2020.
- [ ] Sea level rise is caused by an increase in rainfall.
- [ ] The number of high tide flood events seems to be positively correlated with sea level.
- [ ] High tide flood events cause sea level to rise.
- [ ] Annual mean sea level in Charleston is decreasing.